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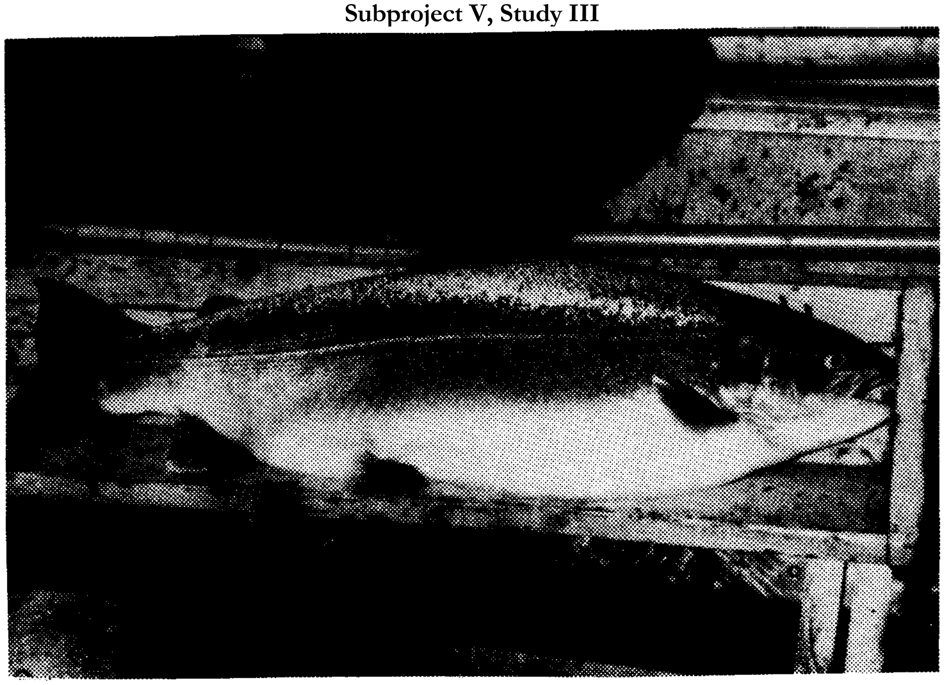
FISHERY RESEARCH

Job Performance Report
Project F-73-R16

PUT-AND-GROW TROUT EVALUATIONS

Subproject V, Study III



Job 1. Fingerling/Catchable Evaluations
Job 2. Rainbow Trout Food Habits and Growth

by

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JOB PERFORMANCE REPORT

State of: **Idaho**

Project: **F-73-R-16**

Subproject: **V**

Study: **III**

Name: **Put-and-Take Hatchery Trout Evaluations**

Title: **Fingerling/Catchable Evaluations**

Job: **1**

Period Covered: **April 1, 1993 to March 31, 1994**

ABSTRACT

We began new stocking evaluations in 1992 to compare the relative returns and costs to the creel for fingerling versus catchable rainbow trout *Oncorhynchus mykiss* in 13 lakes and reservoirs statewide. All waters were stocked with both fingerlings and catchables. We conducted stratified random creel censuses to document relative returns and cost per fish in the creel in each water. We also assessed limnological characteristics, zooplankton size and species composition and fish community in each.

The 1993 return data are incomplete for most of the study waters. Returns for 1992 catchables ranged from 6.4% in Spirit Lake to 60.8% in Winder Reservoir, with estimated cost per fish harvested of $8.48 and $0.89, respectively. Two-year cumulative returns (and cost per fish) on Magic and Little Wood reservoirs were 28.4% ($1.90) and 38.1% ($1.41), respectively. The majority of the harvest in both occurred the year of stocking; weight returns on catchables were 30.5% in Magic and 58.5% in Little Wood reservoirs.

Spring fingerlings were evaluated in Magic and Little Wood reservoirs. For 1992-stocked fish (80 mm), cumulative weight returns through 1993 were 138% and 299%, respectively. Approximate costs per fish in the creel were $1.32 in Magic Reservoir and $0.64 in Little Wood Reservoir.

Evaluations of 1992 fall fingerlings were completed in two of the study waters. Return by number through 1993 was 0.1% in Magic Reservoir and 0.3% in Little Wood Reservoir; cost per fish in the creel was $124 and $38, respectively. Based on electrofishing surveys, fall fingerlings also had poor or no survival in Twin Lakes, Chesterfield Reservoir, and Winder Reservoir. We should monitor the performance of 1993 fall fingerlings, which were stocked under much better water conditions than the 1992 fish.

We also assessed survival and growth of 1992-stocked catchables and fingerlings in one trophy trout water, Daniels Reservoir. We used two methods to estimate abundance. One was a standard Peterson mark-recapture estimate and the other was a one-sample estimate using 1993-stocked catchables as the marked group. The one-sample method required about half the effort of the Peterson estimate, and confidence intervals were smaller. Survival after 1 year was poor

at 4.8 to 5.9% and 8.7 to 15.7% for catchables and fingerlings, respectiviely. Growth rates were good, but fish survival and condition were poor. Stocking rates in trophy waters should probably be at least 50% lower than in general regualtion waters.

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INTRODUCTION

Rainbow trout Oncorhynchus mykiss are the most popular game fish in Idaho (Reid 1989). To meet this demand, the Idaho Department of Fish and Game (IDFG) resident hatcheries produce over 8 million rainbow trout annually for stocking into lakes, reservoirs and streams statewide (Dillon and Megargle 1994). Our annual resident hatchery budget ($2.65 million) represents 35% of the annual resident fisheries budget of $7.54 million.

About 75% of the catchable-size fish and 90% of the fingerling rainbow trout IDFG produces are stocked in lakes and reservoirs. Most waters receive some combination of spring and fall fingerlings in addition to catchable-size fish. In most of these waters, fish stocked at catchable sizes can grow substantially before they are harvested. Thus, many waters stocked with catchable-size fish are essentially managed as put-and-grow fisheries.

Because of hatchery program costs, it is important to maximize the efficiency of stocking. This means determining the best size of fish, number, and time of year to stock in each water. In the past, few stocking evaluations in Idaho have compared relative returns of fingerling and catchable-size fish in lakes and reservoirs (Dillon and Megargle 1994). Stocking strategies have been developed based on the experience and trial-and-error of individual fisheries managers. As with most other states, we have no standardized approach to determine appropriate stocking strategies. We have return targets for fingerling fisheries (100% by weight; IDFG 1990), but it is unclear how often we meet this objective.

IDFG began new stocking evaluations in 1992 to better define the tradeoffs between fingerling and catchable stocking strategies in Idaho lakes and reservoirs. I also included data from evaluations begun in 1990 and 1991 on two waters. This report provides preliminary results, but most of the present evaluations will not be completed until fall of 1994. Final results will allow us to develop stocking criteria for fingerlings. These will include a description of lake types (productivity, fish community) in which fingerling stocking is likely to be successful, and recommendations for size, stocking density and timing to optimize survival and returns.

IDFG currently manages ten lakes and reservoirs for trophy trout. These are also stocked with various combinations of fingerlings and catchables. Regulations focus on restricting harvest, with a two-fish >20 in (508 mm) bag limit and artificial lures and flies with barbless hooks only. The objective of the regulation is to reduce angling mortality and provide increased catch rates with at least 20% of the fish >400 mm (IDFG 1991).

Despite IDFG's stated objective for trophy trout waters, many anglers expect these waters to provide regular catches of 20-in trout (Don Anderson, Dick Scully, IDFG, personal communication). It remains unclear, however, whether most of these waters have the ability to consistently produce trophy fish. Trout growth rates, survival, and longevity determine trophy potential. Growth and survival are influenced by forage availability and fish densities (stocking rates), and domesticated hatchery fish are typically short-lived, persisting only

2-3 years after stocking (Dillon and Megargle 1994). In 1993, we attempted to evaluate recruitment (number stocked), growth and survival of rainbow trout in two reservoirs, Daniels and 24-Mile.

PROJECT GOAL

To maximize the effectiveness of trout stocking programs in lakes and reservoirs to meet management goals for Idaho fisheries.

OBJECTIVES

1. To describe lake characteristics associated with successful and unsuccessful put-and-grow trout fisheries.
2. To develop stocking guidelines (size, stocking density, timing) for fingerling trout in lakes and reservoirs.
3. Describe potential trophy trout production in Daniels and 24-Mile reservoirs.

STUDY AREA

For the 1993 evaluations, we included 11 study waters (Figure 1) representing a range of conditions (productivity and species compositions). Two reservoirs, Daniels and 24-Mile, are managed under trophy regulations (two-fish limit, none under 508 mm). We also included data from recently completed stocking evaluations on C.J. Strike Reservoir (Allen and Holubetz 1993) and Cascade Reservoir (Janssen and Anderson 1993).

METHODS

Fingerling-Catchable Tradeoffs

Stocking

IDFG stocked differentially marked fingerling and catchable rainbow trout into each study water. Stocking rates and sizes varied with management strategies for individual waters (Table 1). All waters received catchable-sized (200-250 mm total length) fish. Fingerlings were stocked in the spring (75-100 mm), in the fall (125-175 mm), or both.

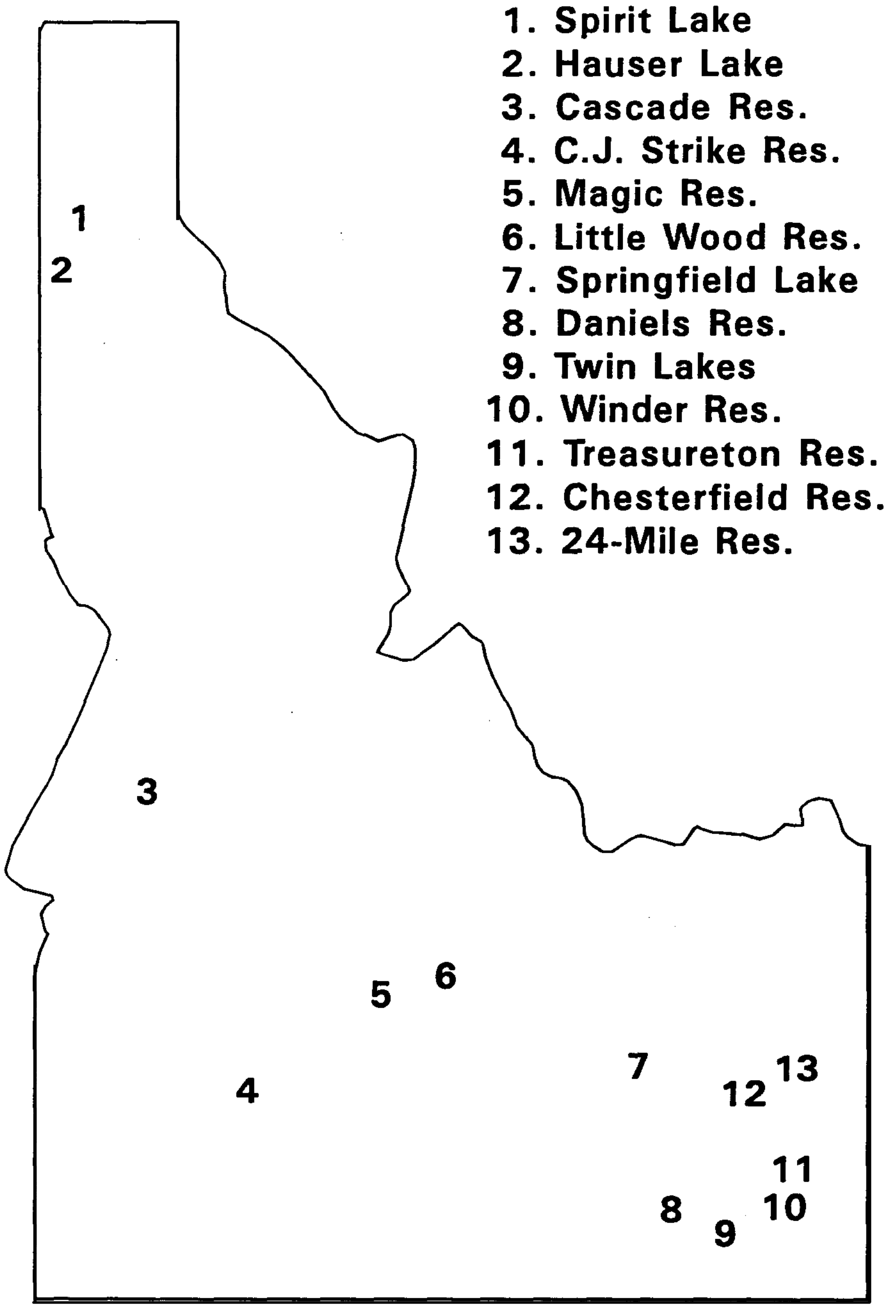

Figure 1. Locations of study waters for fingerling-catchable stocking experiments.

Table 1. Rainbow trout stocking data for 13 Idaho waters with fingerlings-catchable stocking evaluation (IDFG hatchery records.

Water	Year	Number of catchables stocked	Date	Mean length (mm)	ID mark'	Number of fingerlings stocked	Date	Mean length (mm)	ID mark
Spirit Lake	1992	7,000	04/92		AC	45,000			NM
Hauser Lake	1992	9,000	04/92		AC	19,000			NM
Cascade Reservoir	1990	0	-		-	169,000	09/90	165	LV
						145,000	05/90	178	RV
						130,000	10/90	124	AC
						265,000	06/90	150	NM
	1991	150,000	06/91	250	RM	100,000	05/91	114	NM
						139,500	10/91	150	RD
						145,600	10/91	165	OD
						111,220	10/91	178	GD
C.J. Strike Reservoir	1991	0	-	-	-	26,390	12/16	140	
	1992	0	-	-	-	7,875	03/25	203	
Magic Reservoir	1992	33,850	05/07	224	LM	201,400	04/02	83	NM
						97,345		120	AC
	1993	36,400	05/26	221	RM	387,050	04/09	100	NM
						50,868	10/22	138	AC
						216,345	10/08	131	NM
Little Wood Reservoir	1992	7,600	04/92	229	LM	54,000	04/92	80	NM
						15,000	09/92	125	AC
	1993	10,113	05/93	250	RM	48,600	05/93	78	NM
						54,000	10/93	125	AC

J1 T1

Table 1. continued.

Water	Year	Number of catchables stocked	Date	Mean length (mm)	ID Mark[a]	Number of fingerlings stocked	Date	Mean length (mm1	ID mark`
Springfield Reservoir	1992	3,073	02/92	264	AC	25,008	10/92	157	NM
		2,000	05/92	239	AC				
		1,680	06/92	244	AC				
Daniels Reservoir	1992	4,690	03/92	196	AC	15,829	09/92	162	NM
	1993	4,688	05/93	229	LM	15,951	10/93	127	NM
Twin Lakes	1992	11,076	05/92	244	AC	37,630	09/92	163	NM
	1993	11,141	05/93	229	LM	37,637	09/93	152	NM
Winder Reservoir	1992	13,198	05/92	241	AC	9,944	09/92	160	NM
	1993	2,349	05/93	229	LM	6,450	09/93	127	NM
Treasureton Reservoir	1992	15,960	05/92	239	AC	0	-	-	-
	1993	16,002	05/93	229	LM	54,060	09/93	152	NM
Chesterfield Reservoir	1992	20,000	03/92	193	AC	134,995	09/92	160	NM
	1993	39,995	05/93	229	LM	129,850	09/93	165	NM
24-Mile Reservoir	1992	1,136	05/92	244	AC	1,859	09/92	160	NM
	1993	550	05/93	229	LM	1,860	09/93	152	NM

[a] LV = left ventral clip; RV = right ventral clip) AC = adipose clip; NM = not marked; RD = red dye mark; OD = orange dye mark; GD = green dye mark; RM = right maxillary clip; LM = left maxillary clip.

We estimated mean size at stocking in most cases by measuring total length (millimeter) of 100 fish prior to release (Table 1). For five waters (Spirit Lake, Hauser Lake, Cascade Reservoir, C.J. Strike Reservoir, and Little Wood Reservoir), mean lengths were approximated from pound counts. Various combinations of maxillary clips, fin clips, and dye marking were used to identify year and size at planting in 12 waters (Table 1). In C.J. Strike Reservoir, fingerlings and catchables in the creel were identified by fin erosion patterns. In the remaining waters, fingerlings were marked only when we needed to differentiate between spring and fall releases, or to identify different strains stocked at the same time.

We rated the condition of fish at planting using the pyloric fat index (PFI; Goede 1987) for seven waters in 1992 and nine waters in 1993. A minimum of 30 fish were anesthetized and eviscerated at the hatchery. We visually estimated PFIs for individual fish as:

0 - no fat apparent on the pyloric cecae
1 - <50% of the cecae covered with fat
2 - 50% covered
3 - >50% but less than 100% covered
4 - 100% of the cecae covered with fat

We used the mean of individual PFIs to represent condition of the fish at planting.

Contribution to the Creel

Complete randomized creel censuses were developed for each fishery to monitor returns and contribution to the creel of marked groups (McArthur 1993). Creel clerks were instructed to check individual fish for marks and record lengths and weights of harvested fish.

I used return estimates from creel census data and hatchery rearing and planting costs to estimate cost per fish harvested for each stocked group and lake. For put-and-take fish I calculated both standardized and actual costs to the creel. Standardized cost was based on the statewide average cost to raise one put-and-take fish ($0.54; Appendix A). Production and transport costs actually vary from one hatchery to another, however (Appendix A). Actual cost to the creel was based on rearing and transport costs for the the particular hatchery providing the fish to each water (Appendix A). No hatchery-specific cost estimates were available for spring or fall fingerling rainbow trout. I used the mean cost per kilogram of catchable fish ($3.58/kg; IDFG unpublished data) to estimate cost per spring and fall fingerling at $0.05 and $0.12, respectively.

Growth and Condition

We sampled nine waters monthly (May-Oct) by electrofishing to monitor growth and condition of stocked fish. We measured (mm) and weighed (g) all marked fish captured. We estimated average growth through October by comparing mean length at capture to mean length at stocking. Growth of spring-planted fish through October was expressed as millimeter per day. Growth of the previous year's fall fingerlings was expressed as millimeter per year.

We used relative weight (Wr; Anderson 1980) to describe average monthly condition of sampled fish. We calculated individual relative weights as:

$$Wr = \frac{\text{Observed Weight}}{\text{Standard Weight}} \times 100 \qquad (1)$$

Standard weights (Ws) were based on the formula:

$$\text{LogWs} = -5.194 + 3.098\text{LogL} \text{ (Anderson 1980)}$$

where L = total length (mm).

Lake Characteristics

To describe the influence of lake characteristics on rainbow trout growth and returns we collected basic limnology, morphometry, and species composition data for each water. Limnology data were collected two to three times from May-September and included:

1. Total phosphorous
2. Alkalinity
3. Total dissolved solids
4. Conductivity
5. Temperature and oxygen profiles
6. Secchi disk transparency
7. Zooplankton species composition and size structure

Sampling and analysis methods are reported in detail in Dillinger (1993).

We also described useable trout habitat (UTH) and maximum trout habitat (MTH) in June, July, and September for six waters, and in June and August for another six. Useable trout habitat was defined as water with temperatures ≤19°C and oxygen ≥5mg/l (Heimer and Howser 1990), while MTH was defined as water with temperatures ≤21°C and oxygen ≥3mg/l (after Van Velson 1986).

Trophy Trout Evaluations

In May of 1993, we attempted to estimate survival of fish stocked in 1992 into the two trophy waters, Daniels and 24-Mile reservoirs. These waters have a 20-in (508 mm) minimum length regulation. We assumed, therefore, that none of the fish planted in March (196 mm) and September (162 mm) of 1992 were harvested prior to our sampling.

Prior to stocking the 1993 catchables, we electrofished for two nights on Daniels Reservoir and one night on 24-Mile Reservoir. We recorded lengths and marked all captured fish with a caudal fin punch. The 1993 catchables were stocked 2 d later. We did recapture runs 11-12 d after the marking runs.

We estimated abundance of 1992 stocked fish and earlier plants by two methods. We calculated one estimate by the standard Peterson approach (Ricker 1975) using the above electrofishing captures as marked fish. We then calculated one-sample estimates using the 1993-stocked catchables as the marked group (Hepworth et al. 1991) with the following formula:

$$N = \frac{(M+1)(C+l)}{(R+1)} - M \qquad (2)$$

where M = number of newly stocked fish
C = number of other fish sampled in the recapture run
R = number of newly stocked fish recaptured

We expressed survival of 1992 stocked fish as a percentage of the numbers stocked for each group. We estimated standing stock (kilogram per hectare) for each group using a mean weight from the total electrofishing catch. We excluded the 1993 stocked fish from our estimate of total standing stock.

RESULTS

Fingerling-Catchable Tradeoffs

Contribution to the Creel

The 1993 harvest estimates for the seven Southeast Region and two Panhandle Region waters were not completed in time for inclusion in this report. We include here the 1992 and 1993 creel census results for Magic and Little Wood reservoirs (Table 2), in addition to earlier data for other waters (Appendix B).

Return rates in 1993 for fall 1992 fingerlings were 0.3% in Little Wood Reservoir and 0.1% in Magic Reservoir (Table 2). No estimate of weight return was possible due to low samples from the creel.

Table 2. Summary of stocking, effort, returns, and cost per fish in the creel for fingerling and catchable rainbow trout in Magic and Little Wood reservoirs, 1992-1993.

Water and year	Number stocked	Size (mm	Weight stocked (kg)	1992 Effort (h/hectare)	1993 Effort (h/hectare)	1992 Returns Number (%)	1992 Returns Proportion of total harvest	1993 Returns Number (%)	1993 Returns Proportion of total harvest	Total returns through 1993 Number (%)	Total returns through 1993 kg (%)	Estimated per return through 1993[a]
Magic Reservoir 1992												
spring fingerlings	201,400	83	1,679	300	71	6,180 (3.1)	29%	1,469 (0.7)	10%	7,649 (3.8)	2,324 (138)	$1.32
spring catchables	33,850	224	4,207	300	71	9,363 (27.6)	45%	242 (0.8)	2%	9,605 (28.4)	2,300 (55)	$1.90
fall fingerlings	97,345	120	1,952	300	71	-	-	94 (0.1)	<1%	94 (0.1)	-	$124.00
Magic Reservoir 1993												
spring fingerlings		100	3,280		71	-	-	1,836 (0.5)	13%	1,836 (0.5)	215 (6.5)	$10.54
spring catchables	36,400	221	4,313		71	-	-	10,208 (28.1)	70%	10,208 (28.1)	3,688 (8.6)	$1.94
fall fingerlings	50,868	165	1,839		71	-	-	-		-	-	-
Little Wood Reservoir 1992												
spring fingerlings	54,000	80	303	250	89	0	0	3,687 (7.2)	30%	3,687 (7.2)	907 (299)	$0.64
spring catchables	7,600	229	1,011	250	89	2,400 (31.5)	31%	505 (6.6)	4%	2,905 (38.1)	592 (58.5	$1.41
fall fingerlings	15,000	125	325	250	89	-	-	47 (0.3)	<1%	47 (0.3)		$38.00
Little Wood Reservoir 1993												
spring fingerlings	48,600	78	256	-	89	-	-	179 (0.4)	<1%	179 (0.4)	-	$13.57
spring catchables	10,113	250	1,750		89	-	-	6,395 (63.2)	50%	6,395 (63.2)	1,358 (78)	$0.85
fall fingerlings	54,000	125	1,171	-	89	-	-	-	-	-	-	-

[a] Based on cost per fish stocked of $0.05 for spring fingerlings, $0.12 for fall fingerlings, and $0.54 for catchables.

J1-T2

First-year returns by number for spring 1993 fingerlings were 0.4 and 0.5% in Little Wood and Magic reservoirs, respectively (Table 2). Cumulative returns after 2 years for spring 1992 fingerlings were 7.2 and 3.8% in Little Wood and Magic reservoirs, respectively. Cumulative weight return was almost 300% in Little Wood Reservoir and 138% in Magic Reservoir. Spring 1992 fingerlings comprised 30% and 10% of the 1993 harvest in Little Wood and Magic reservoirs, respectively.

Estimated cost per harvested fall 1992 fingerling was $38.00 in Little Wood Reservoir and $124.00 in Magic Reservoir (Table 2). Cost per harvested spring 1992 fingerling was $1.11 in Little Wood Reservoir and $2.10 in Magic Reservoir.

First-year returns of 1992 catchables ranged from 6.4% in Spirit Lake to 60.8% in Winder Reservoir (Appendix B). Cumulative returns by number after 2 years were 38.2% in Little Wood Reservoir and 28.4% in Magic Reservoir. Cumulative weight return was 58.5% in Little Wood Reservoir and 30.5% in Magic Reservoir (Table 2). For 1993 catchables, return by number was 28% in Magic Reservoir and 63% in Little Wood Reservoir, and they comprised 70% and 50% of the total harvest, respectively (Table 2).

Growth and Condition

Growth through mid-October for 1993 catchables ranged from 0.34 mm/d in Little Wood Reservoir to 1.39 mm/d in Springfield Lake (Figure 2; Appendix C). In most waters, growth was similar to or slightly better than in 1992. Growth of spring fingerlings was 0.88 and 0.93 mm/d in Magic and Little Wood reservoirs, respectively, which was also slightly better than in 1992 (Figure 3). Fall fingerlings were virtually absent from four of the eight waters into which they were stocked in 1992. In Winder Reservoir, no 1992 fall fingerlings were sampled after July, 1993. Annual growth (to October 1993) in the remaining three waters was 235, 241, and 305 mm in Daniels, 24-Mile, and Springfield reservoirs, respectively (Figure 4).

Mean rainbow trout relative weights (all stocked groups combined) were near or above 100 in most of the study waters from May to October (Figure 5). In Daniels and 24-Mile reservoirs, relative weights were well below 100 for most of the growing season. In most waters and months, relative weight declined for fish >400 mm (Appendix D).

Lake Characteristics

Fish species composition and limnological characteristics for each water are presented in Appendix E. Three of the study waters (Daniels, Chesterfield, and Treasureton reservoirs) contained only salmonids. In Magic Reservoir, yellow perch *Perca flavescens*, bridgelip suckers *Catostomus columbianus*, and redside shiners *Richardsonius balteatus* were present but not abundant. Little Wood Reservoir contained bridgelip suckers, and 24-Mile Reservoir contained mountain

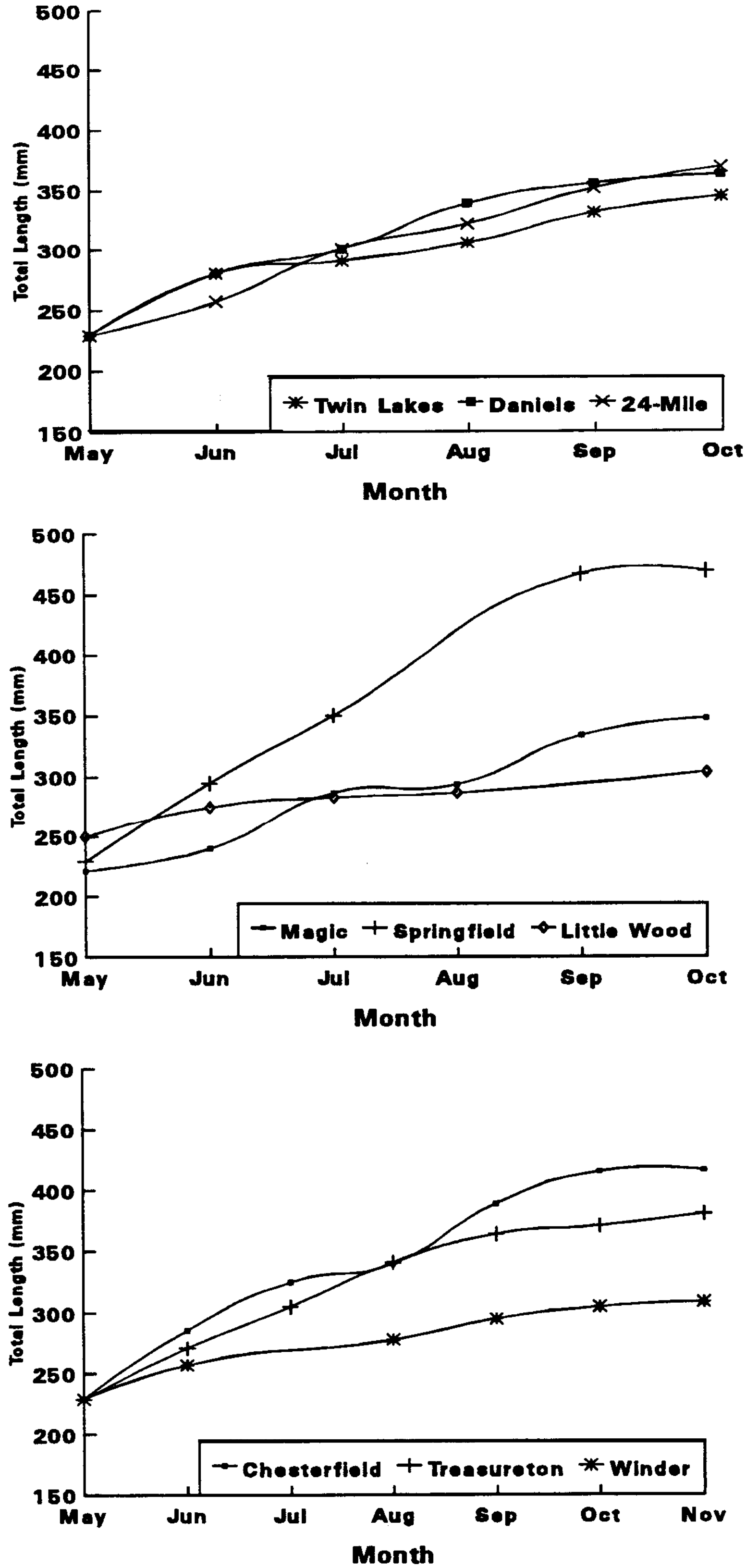

Figure 2. Growth for catchable rainbow trout in nine Idaho lakes and reservoirs, May to October 1993.

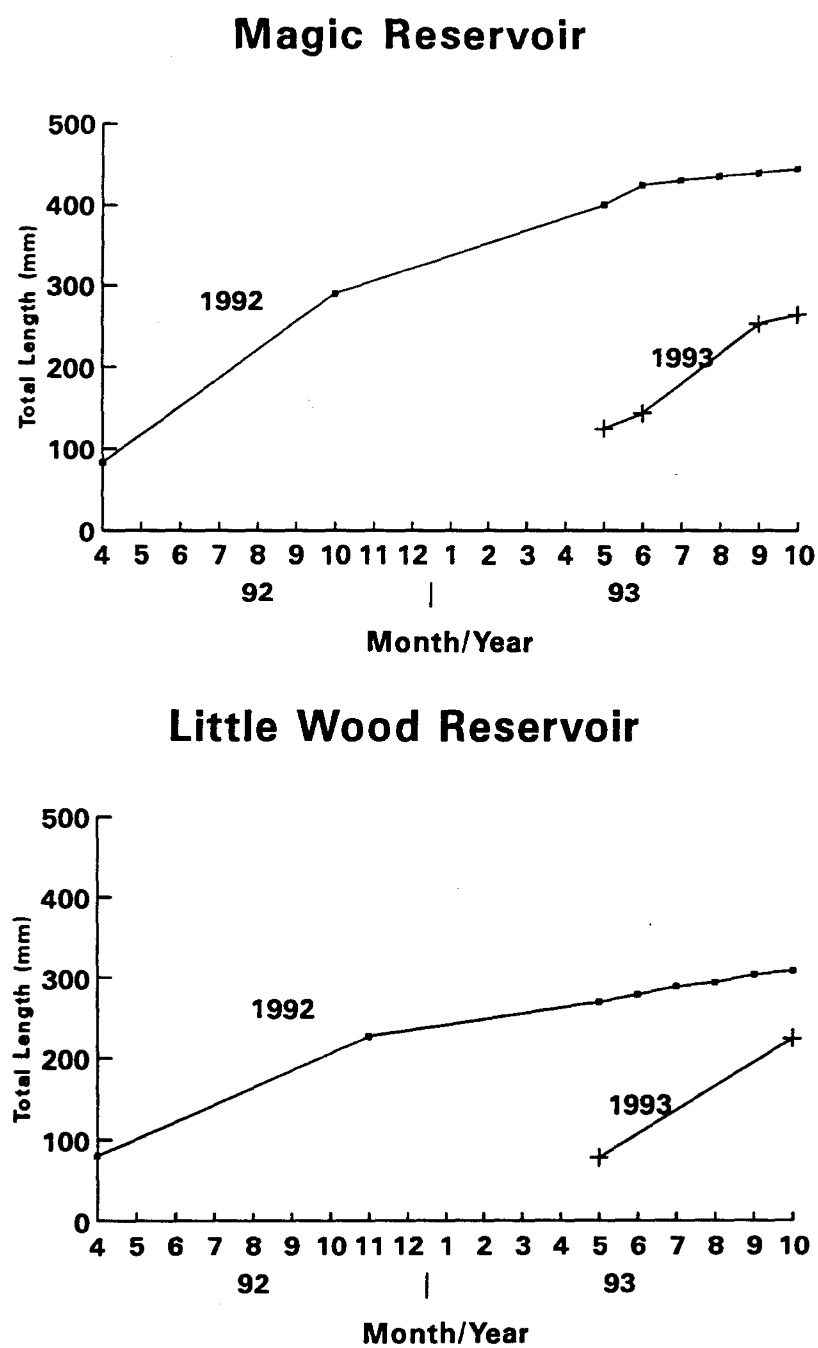

Figure 3. Growth of 1992 and 1993 spring fingerling rainbow trout through October 1993 in Magic and Little Wood reservoirs.

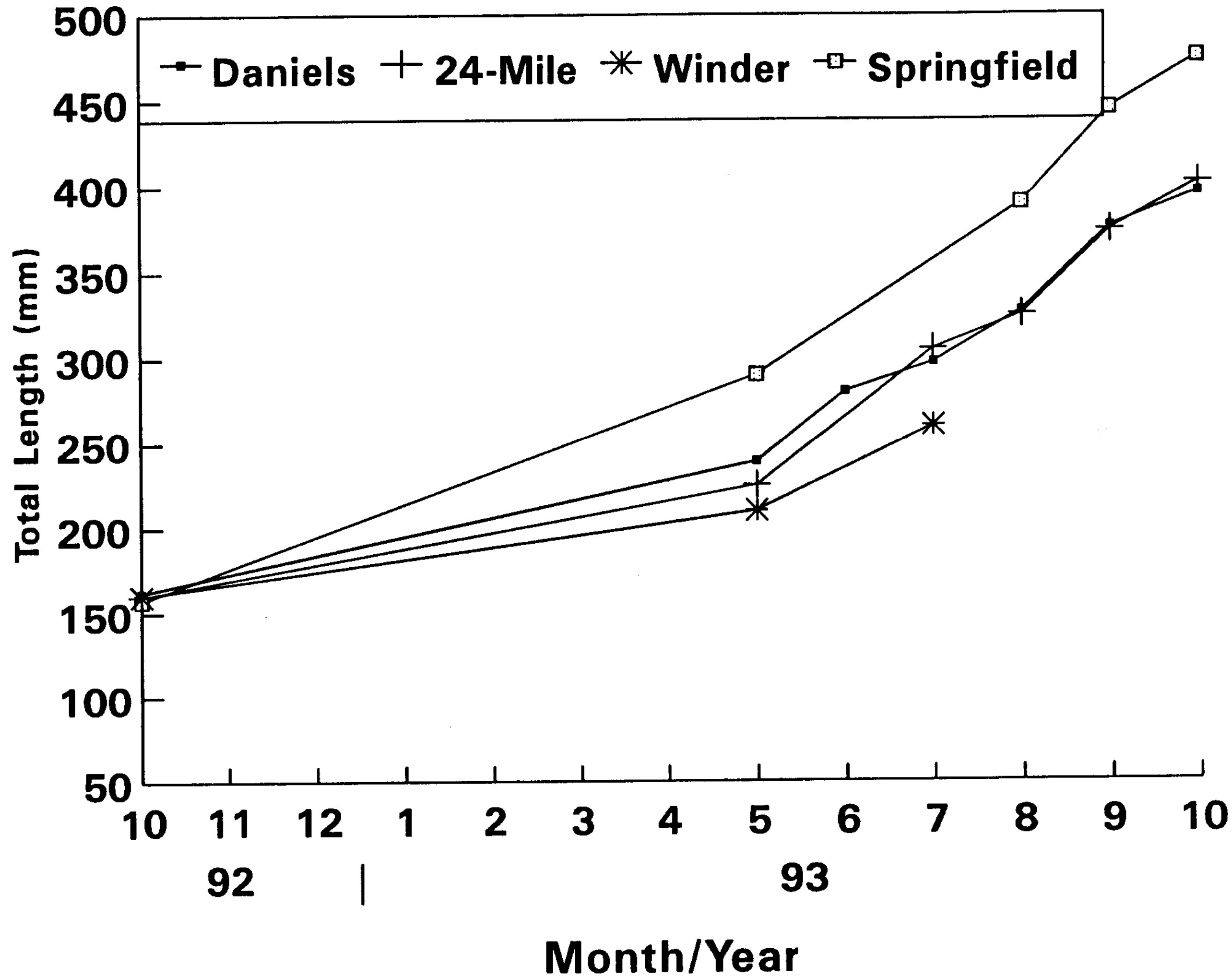

Figure 4. Growth of 1993 fall fingerling rainbow trout through October 1993 in four southern Idaho reservoirs.

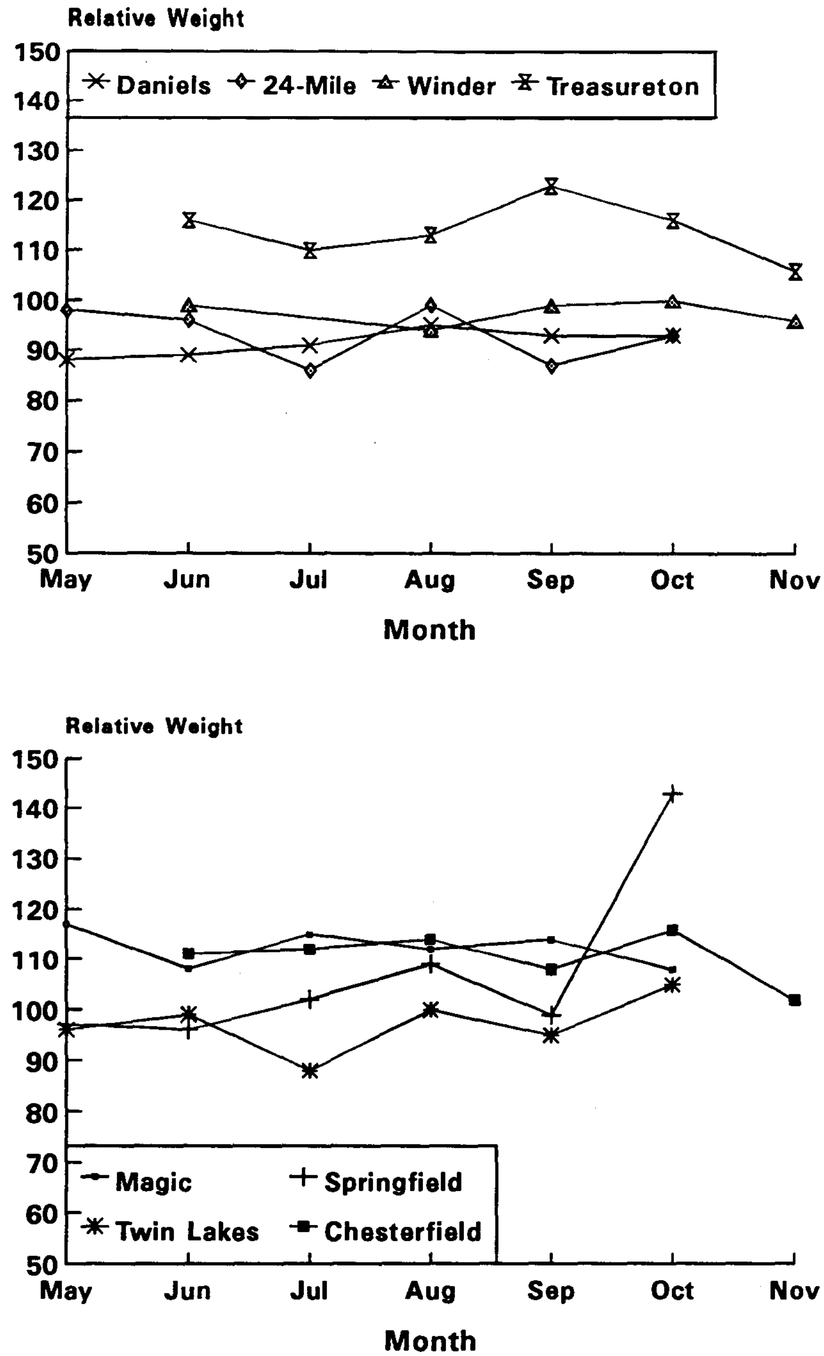

Figure 5. Mean monthly relative weight (all sizes combined) for rainbow trout in eight Idaho reservoirs, 1993.

suckers Catostomus platyrhynchus. The remaining study waters had complex fish communities, including potentially competing and predatory species.

Zooplankton composition and size frequencies are provided in Appendix F. Although sample sizes from some waters were small, we sampled no zooplankton ≥1.5 mm in Spirit, Hauser, and Little Payette lakes.

For most of the evaluation waters in southern Idaho, temperature and oxygen constraints did not significantly limit trout habitat. In Springfield, 24-Mile, Magic, and Little Wood reservoirs, trout habitat was present throughout the water column (Appendix G). In Daniels Reservoir in June, UTH was present in the top 9.5 m of the water column, and all of the reservoir was MTH. In June and July, the upper 7-8 m of Twin Lakes was UTH, and the entire water column was MTH.

Because we do not yet have 1993 return data for most of the study waters, we could not attempt to analyze the influences of lake characteristics on returns of stocked fish. A comprehensive analysis will be a priority in the next year.

Trophy Trout Evaluations

Survival Estimates

Electrofishing capture rates were too low in 24-Mile Reservoir to derive population estimates using either method. Survival estimates were not feasible.

Population estimates derived from the two methods were considerably different for some groups of fish in Daniels Reservoir. Recapture rates were generally low (Appendix H) and confidence intervals on the estimates were wide using the standard Peterson method (Table 3). Confidence intervals were smaller on the one-sample estimates. No estimate for cutthroat trout was possible with the Peterson method because we had no recaptures.

Survival estimates after one year for 1992 spring-planted fish (196 mm) were 4.8% and 5.9% using the standard Peterson method and one-sample method, respectively (Table 3). Survival estimates for fall-planted fish (162 mm) were 15.1 and 8.7%, respectively.

Biomass estimates also varied in accordance with population estimates. Using standard Peterson methods, our estimate of trout biomass (excluding cutthroat trout Oncorhynchus clarki) was 1,434 kg or 9.4 kg/hectare (Table 4). Our estimate using the one-sample method (including cutthroat trout) was 1,945 kg or 12.4 kg/hectare.

Excluding the 1993 catchables, over 40% of the trout population in Daniels Reservoir exceeded 400 mm (Appendix I).

Table 3. Population and survival estimates (±95% confidence intervals) for 1992 spring and fall-stocked rainbow trout in Daniels Reservior through May 18, 1993.

Size stocked	Date stocked	Number stocked	May 1993 population estimate M-R[a]	May 1993 population estimate O-S[b]	Survival (%) M-R	Survival (%) 0-S
196 mm	3/31/92	4,690	224 (±194)	279 (±135)	4.8 (±4.1)	5.9 (±2.9)
162 mm	9/28/92	15,829	2,392 (±2,309)	1,372 (±225)	15.1 (±14.6)	8.7 (±1.5)

[a] M-R = standard Peterson estimate
[b] 0-S = one-sample estimate using 1993-stocked fish as a marked group

J1 T3

Table 4. Population and biomass estimates for Daniels Reservoir, May 1993, using standard mark-recapture methods (M-R) and a one-sample (0-S) estimate with newly stocked fish as a marked group.

Method	Fish Group	Population estimate	Mean Weight (a)	Density Fish/ hectare	Density kg/ hectare
M-R	Spring 1992 put-and-take	224	399.	1.5	0.8
	Fall 1992 put-and-grow	2,392	122	15.7	1.9
	Unmarked rainbow trout	1,554	600	10.2	6.1
	Cutthroat x rainbow hybrid	218	572	1.4	0.6
	Cutthroat	no eat.	-	-	-
	Totals	4,388	-	28.8	9.4
0-S	Spring 1992 put-and-take	279	399	1.8	0.7
	Fall 1992 put-and-grow	1,372	122	9.1	1.9
	Unmarked rainbow trout	2,271	600	14.6	8.7
	Cutthroat x rainbow hybrids	301	572	1.9	1.1
	Cutthroat	194	679	1.2	0.8
	Totals	4,417	-	28.6	12.4

J1 T4

DISCUSSION

Fingerling-Catchable Tradeoffs

Because we do not have complete creel census data for 1993 in each water, our analysis and interpretation is limited. These data and information from other ongoing IDFG fingerling/catchable evaluations will be built into a comprehensive analysis in the next year.

Even given limited data, however, one of the clear trends found thus far is the poor performance of fall fingerlings. Based on our electrofishing surveys, fish stocked in fall of 1992 virtually disappeared by spring 1993 in four of the eight study waters (Magic, Little Wood, Twin, and Chesterfield reservoirs), and were not sampled after June 1993 in Winder Reservoir. Creel census data supported our findings in Magic and Little Wood reservoirs, i.e. very low return on fall fingerlings. In Daniels Reservoir, survival of fall 1992 fingerlings was estimated at 2.4-5.9% after 7 months. We still need harvest estimates from management staff to describe returns and costs to the creel in the other study waters.

Though preliminary results suggest poor performance of fall 1992 fingerlings, it is important to note that 1992 was a severe drought year, and fish were stocked under very low water conditions. In 1993, fall fingerlings were stocked under much better water conditions. It will be important to monitor performance and return of the 1993 fish to see if survival improves with higher water levels.

Spring fingerlings planted in 1992 were evaluated in only Magic and Little Wood reservoirs. In both, the weight return exceeded the 100% goal, and they contributed significantly to the overall harvest. Weight return was higher in Little Wood Reservoir than in Magic Reservoir despite poorer growth. This was related to timing of harvest; over 80% of the spring fingerling harvest in Magic Reservoir occurred the year of planting, while in Little Wood Reservoir none were harvested until the following year.

Weight returns for catchables in Magic and Little Wood reservoirs were also influenced primarily by the timing of harvest rather than growth rates in the reservoirs. Return of 1992 catchables through 1993 in Magic Reservoir was 28.4% by number and 30.5% by weight. Over 85% of the harvest occured within 4 months of planting. In Little Wood Reservoir, return of 1992 catchables was 38.2% by number and 58.5% by weight. Just 47% of the harvest occured in the first 4 months. This provided a better total weight return, despite the poorer growth compared to that in Magic Reservoir. Neither of these plants would have met the weight return goal of 100% if they were considered put-and-grow fish. Again, however, water conditions were poor in 1992, and second-year returns (and total weight returns) might improve for the plants in these waters.

Several other stocking evaluations are ongoing around the state, including various combinations of season and size at planting. These are being conducted by management personnel, and as data become available they will be included in an overall analysis. Ultimately, we will use the results of our study to describe on a broad scale the best size and season to stock rainbow trout in different water types. For example, if fall fingerlings consistently show poor returns and high cost to the creel, we may want to shift emphasis to spring plants. Based on our preliminary results, even moderate increases in spring stocking might fully compensate for dropping fall stocking altogether.

On another level, we hope to refine the preliminary stocking rate guidelines for fingerling rainbow trout we developed in 1993 (Dillon and Megargle 1993). Stocking rate guidelines represent a way to match stocking density to lake productivity and angling effort. For catchables, the best approach is probably to describe stocking relationships derived from past creel census data on lakes and reservoirs, and base guidelines on these relationships (e.g. stocking rate vs catch rate, effort vs return). These relationships are currently being developed (Gregg Mauser, IDFG unpublished data). For fingerlings, our completed evaluations will result in stocking guidelines to maximize survival, growth and returns in our hatchery fisheries.

A limitation to past Idaho studies evaluating fingerling stocking success was difficulty in identifying the year and season of stocking for fish observed in the creel. Most frequently, fin erosion has been used to identify catchables in the creel, and fish with little or no fin erosion are usually considered of fingerling origin. Scale analysis can also be used to describe growth and possibly size at stocking to differentiate fingerlings from catchables (Bigelow 1991). Scale analysis is time consuming, however, and both methods have an unknown degree of error. We recommend marking all fish with fin clips, maxillary clips or fluorescent pigments in waters where size-at-stocking evaluations are conducted. Marking allows definitive identification of all planted groups, and aids in creel census data entry and estimations of growth. Differentially marking all stocked groups is especially important in slow-growth waters where stocked year-classes may overlap in length-frequency distribution.

An important limitation to our cost analysis is a lack of information on rearing and stocking costs of trout in each of our resident hatcheries. We have some preliminary figures for catchables but none for spring and fall fingerlings. Because we have no standardized procedures to calculate these costs, each Hatchery Superintendent estimates production costs differently, and the numbers are probably not really comparable. We will develop a standardized accounting procedure in the next year to estimate true costs of hatchery products from each of our resident facilities.

Zooplankton size structure in most of the study waters did not indicate severe cropping; i.e. most contained zooplankton L1.5 mm (Mills and Schiavone 1982; Mills et al. 1987; Appendix F). This suggests that even in waters with diverse fish communities, competition for zooplankton was not an important limitation to trout survival and growth. Rainbow trout feed on a variety of prey types, and will almost exclusively use larger macroinvertebrate prey where available (Jarcik and Dillon 1992; Job 2 this report). Asssessment of competitive interactions between trout and other species often imply that zooplankton is the limiting food source (Stuber et al. 1985). This approach is insufficient, however, given our current knowledge of trout diets in Idaho.

Competition for macroinvertebrate prey appears a more likely mechanism, although food habits data for potentially competing species in Idaho are unavailable.

Trophy Trout Evaluations

Our survival estimates for 1992-stocked fish in Daniels Reservoir indicate that relatively few of these fish will recruit to the trophy fishery. Because of the 508 mm minimum length limit, the population is dominated by larger fish stocked in previous years. Over 40% of the population was >_400 mm. Although we have no comparative data, total population density and biomass is probably high relative to most nearby non-trophy waters.

Consistently lower relative weights in Daniels and 24-Mile reservoirs compared to other Idaho waters suggest fish densities may be too high. Although growth is relatively good and the population size structure in both meets the management objective, the trophy potential of Daniels Reservoir, and probably 24-Mile Reservoir, could be enhanced by decreasing fish densities. It remains unclear how much of a stocking reduction would be necessary to improve growth, especially if lower stocking rates are compensated by increased survival. Beginning in 1992, stocking rates were reduced in both waters to half that of nearby yield fisheries. IDFG should probably evaluate the reduction in stocking rates after 2 or 3 years to assess the effects on fish survival and growth, angler catch rates and yield of trophy fish. Some sacrifice in catch rates may be necessary if increased production of trophy (>508 mm) fish is an important management goal for these fisheries.

Stocking a known number of marked fish for population or survival estimates appears useful, although there are important assumptions associated with the method. We assumed no mortality of newly-stocked fish prior to the recapture effort. Any mortality which did occur would lead to overestimates of abundance for the other fish groups. Another important assumption is equal vulnerability to electrofishing of all fish groups. Recapture rates for the larger unmarked rainbow trout and rainbow trout x cutthroat trout hybrids were higher than for the newly-stocked fish (Appendix H). Thus, our population estimates for the larger fish may be positively biased. The most important benefit of the one-sample method is the time saved. The effort (and cost) of trout population estimates is about half that of conventional mark-recapture methods.

CONCLUSIONS

We cannot draw any substantial conclusions about the performance of fall fingerlings until the 1993 creel summaries are completed. Spring fingerlings are exceeding return goals in Magic and Little Wood reservoirs. Based on our estimates of stocking costs they were more cost-effective in providing fish in the creel than catchables, although catchables provided the majority of the harvest in both waters. Catchables in Magic and Little Wood reservoirs did not meet the weight return goal for put-and-grow fish because most were harvested shortly after stocking.

Stocking rates in trophy waters should probably be lower than in general regulation yield fisheries. Our data suggest stockpiling and relatively poor condition of fish in Daniels and 24-Mile reservoirs, and populations dominated by older year classes. Survival of fish stocked in Daniels Reservoir in 1992 was poor. If the management goal of these fisheries is to increase production and harvest of trophy fish, we recommend continuing to stock both of these fisheries at 50% of the rate used in yield fisheries. The new stocking program should be evaluated after 3 years to document changes in angler catch rates and fish growth, survival and population size structure.

The most efficient means of evaluating stocking stategies is to differentially mark all fish groups stocked. This simplifies creel census and eliminates the need to examine fin erosion or scales to identify origin of stocked fish. We recommend alternating left and right maxillary clips for different years' catchables, and alternating adipose clip and no clip for fingerlings. Fluorescent dye marks could also be used for multiple groups stocked the same year.

It is critical for us to develop a standardized hatchery accounting procedure that describes production costs for various size fish from each of our resident hatcheries. This is the only way we can develop well-founded cost-benefit analyses for different stocking programs.

Although our preliminary results suggest poor peformance of fall fingerlings, the 1992 stocking was under very poor water conditions. We still lack 1993 harvest estimates for several waters. We should continue to monitor these fisheries through 1994 to determine if the fall fingerlings stocked under better water conditions will meet return goals.

RECOMMENDATIONS

1. If increased production of trophy trout is the most important management goal for Daniels and 24-Mile reservoirs, stocking rate should remain at 50% of the rate used in yield fisheries. The fisheries should be evaluated after 3 years to document changes in catch rates and fish growth, survival and size structure.

2. In fisheries scheduled for stocking evaluations, all groups of stocked fish should be differentially marked to ensure proper identification and eliminate the need for scale analysis or other more error-prone identification methods.

3. In the next year, develop a standardized hatchery accounting system to document production costs for different sizes of fish at each resident facility.

4. Continue the stocking evaluations through 1994; include data from other regional stocking evaluations in the analysis.

ACKNOWLEDGEMENTS

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A P P E N D I C E S

Appendix A. Costs to rear and stock catchable rainbow trout at IDFG hatcheries, 1992 (IDFG unpublished data).

Hatchery	Number of fish	Cost ($)	Cost/fish
Hagerman	950,575	182,097	0.19
American Falls	110,600	33,139	0.29
Grace	100,050	35,749	0.36
Nampa	226,100	109,397	0.48
Hayspur	142,250	79,475	0.56
Clearwater	152,500	116,643	0.76
McCall	35,048	29,896	0.85
Mullan	54,050	47,086	0.87
Mackay	105,900	127,662	1.20
Ashton	58,800	78,488	1.33
Clark Fork	149,900	289,979	1.93
Total	2,085,773	1,129,656	0.54

J1 AA

Appendix B. 1992 Creel census data on waters with put-and-take (P&T)/put-and-grow (P&G) experiments.

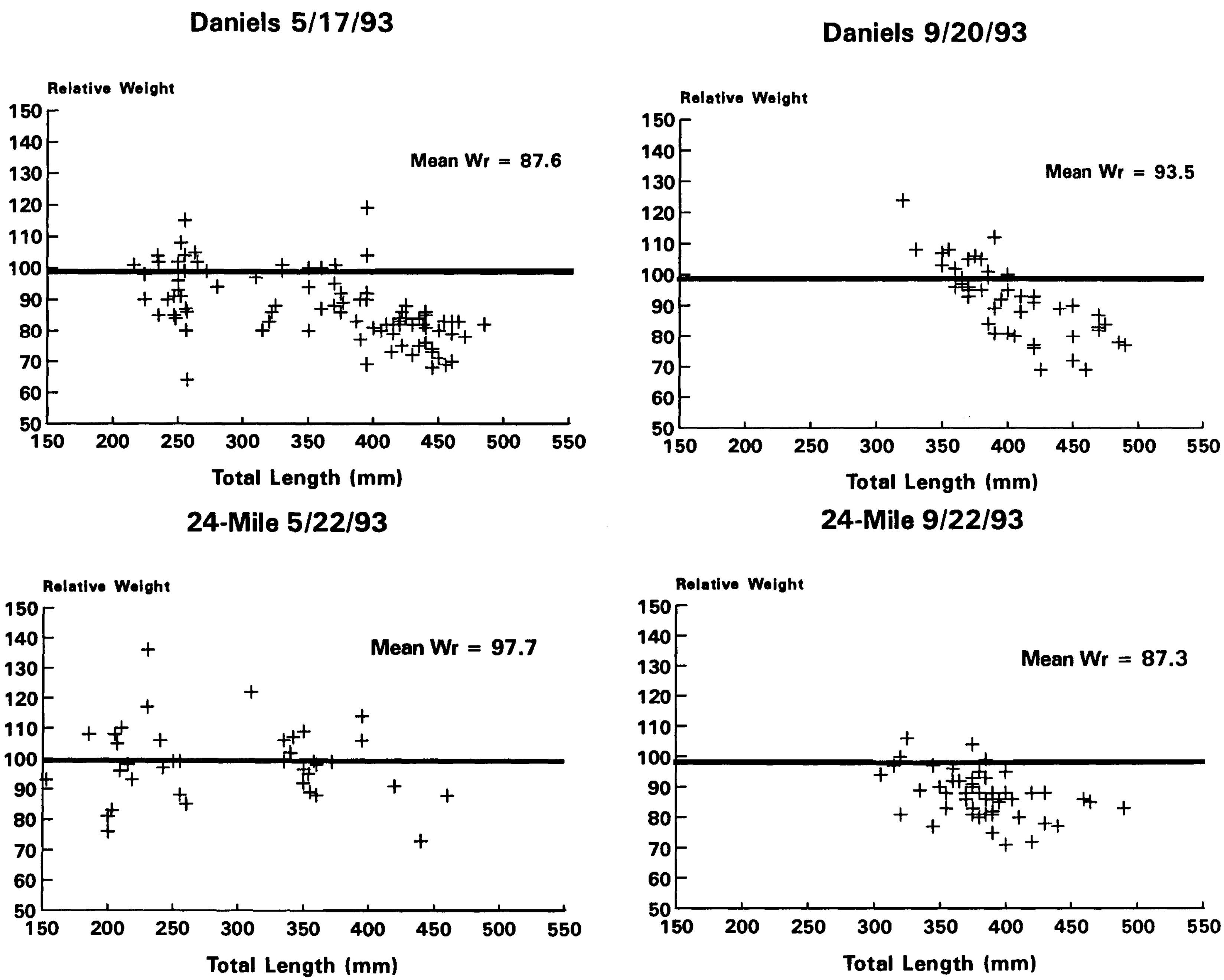
Water	Census period	Number of put-and-take trout stocked	Number of marked put-and grow trout planted[a]	Total effort (hr/hectare)	Catch rate (fish/hour)		Harvest		Return (X) by number		Actual cost/fish creeled ($)		Standardized cost/fish creeled (5)	
					P&G	P&T	P&G	P&T	P&G	P&T	P&G	P&T	P&G	P&T
Magic Reservoir	Jun-Dec	33,850	201,400 (s)	300	-	0.15	-	9,363	-	27.6	-	0.69		1.96
Little Wood Res.	June-Dec	7,600	54,000 (s)	250	-	0.18	-	2,400	-	31.5	-	1.78	-	1.71
Twin Lakes	May-Sep	11,150	-	84	-	0.09	-	1,446	-	12.9	-	2.79	-	4.19
Winder Reservoir	May-Sep	13,160	-	547	-	0.51	-	7,997	-	69.8	-	0.59	-	0.89
Treasureton Res.[b]	May-Aug	16,000	-	350	-	0.68	-	5,823	-	36.4	-	0.99	-	1.48
Springfield Lake[c]	Jul-Sep	8,500	-	129	-	0.11	-	747	-	8.9	-	3.26	-	6.07
Chesterfield Res.[b]	May-Jun	40,000	-	35	-	0.13	-	1,430	-	3.6	-	5.28	-	15.00
C.J. Strike Res.	Apr '92-May '93	0	26,390 (w)	78	0.003		343		1.3	-	3.06	-	4.62	-
			7,875 (s)	78	0.017		1,802		22.9	_	0.69	_	0.66	-
Cascade Res.[d]	Nov '90-Nov '92	150,000		17		0.14		31,500	-	21.0	-	2.53	-	3.42
			169,000 (f)		<0.01		655		0.38	-	18.06	-	-	-
			145,000 (s)		<0.01		1,094		0.75	-	9.19	-	-	-
			130,000 (f)		<0.01		298		0.23	-	30.54	-	-	-
			396,000 (f)		<0.01		58		0.01	-	478.00	-	-	-
Spirit Lake	Apr-Sep	7,000	0	54	-	0.015	-	448	-	6.4	-	30.16	-	8.48
Hauser Lake	Apr-Sep	9,000	-	140	-	0.06	-	2,004	-	22.3	-	8.65	-	2.48

[a] Includes only marked fish stocked in spring (s), fall (f), or winter (w).
b Reservoirs went dry.
[c] Census not started until July; effort, harvest, and returns were underestimated.
[d] The several groups of put-and-grow trout were part of strain/size evaluation.

Appendix C. Growth of catchable hatchery rainbow trout in nine Idaho lakes reservoirs, 1993.

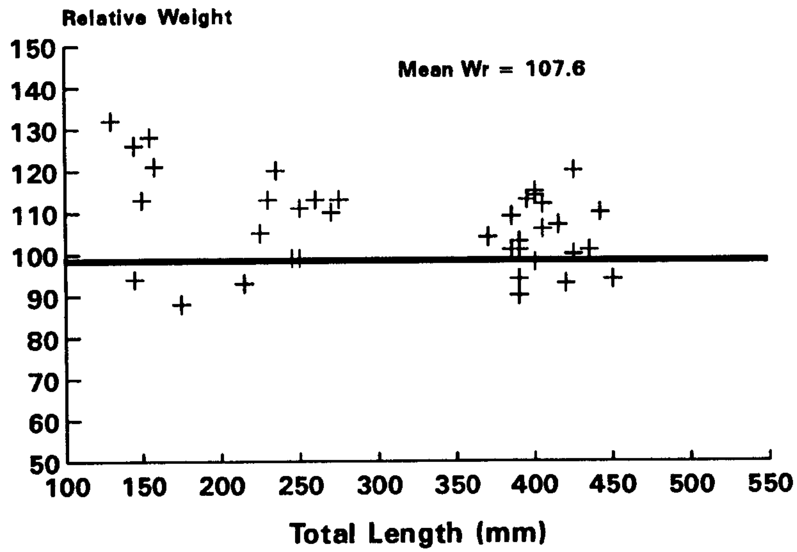
Location	May	June	July	August	September	October	November
Magic Reservoir	226	240	287	294	334	348	-
Little Wood Reservoir	250	270	283	287	-	304	-
Springfield Lake	252	280	350	-	467	469	-
Daniels Reservoir	243	280	300	338	354	361	-
Twin Lakes	246	280	290	305	330	343	-
Winder Reservoir	229	257	-	278	295	305	310
Treasureton Reservoir	229	272	305	341	364	372	381
Chesterfield Reservoir	229	286	325	340	389	416	417
24-Mile Reservoir	229	257	300	321	350	367	-

J1 AC

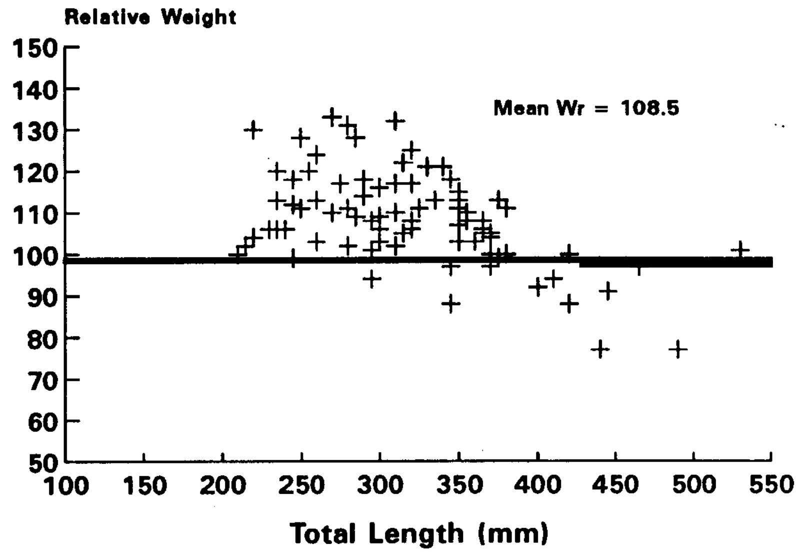


Appendix D. Plots of relative weight versus length for rainbow trout in three waters and two months

Magic 6/17/93



Magic 10/12/93



Appendix D. continued

Appendix E. Limnological data and species composition for Idaho lakes and reservoirs with fingerling-catchable stocking evaluations.

Location	Surface area at full pool (hectares)	Mean depth (m)	Conductivity (mmhos/cm)	Secchi disk transparency (m)	Total phosphorous (mil)	Alkalinity (mall)	Total dissolved solids (mil)	Species composition[a]
Spirit Lake	1,700		50	12.7	0.042	25.0	33.0	KOK, LMB, PMS, YEP, NOP, CT, SCR, PWF
Hauser Lake	245	6.0	45	5.2	0.015	19.2	30.0	PMS, YEP, SCR, BBH, TEN, LMB, TIM
Cascade Reservoir	12,145	17.1	58	2.9	0.050	17.3	38.7	YEP, COH, SMB, SCF, SU, KOK, BBH, MWF
C.J. Strike Reservoir	3,036	2.1	651	1.3	0.042	152.0	434.0	BLG, LMB, SMB, PMS, YEP, SCR, SQF, RSS, SU, CAR, CHS, BBH, CCF
Magic Reservoir	729	32.5	492	2.7	0.022	97.9	328.0	WRB, YEP, SU, RSS
Little Wood Reservoir	238	16.1	295	2.4	-	-	196.7	WRB, SU
Springfield Lake	26	1.6	529	2.7	-	-	352.7	UTS, SU, BRT
Daniels Reservoir	151	7.0	507	2.6	-	-	338.0	LCT, HYB
Twin Lakes	181	9.5	304	3.5	-	-	159.8	CAR, BLG, LMB, TIM, BBH
Winder Reservoir	38	5.4	218	4.1	-	-	145.3	LMB, BLG, GSF
Treasureton Reservoir					-	-	-	Hatchery rainbow trout only
Chesterfield Reservoir	645	4.5	290	1.5	0.045	152.0	193.3	BRT
24-Mile Reservoir	20	3.0	600	6.7	-	-	400	MTS, BKT

[a]Species other than hatchery rainbow trout; KOK - kokanee, LMB largemouth bass, PMS = pumpkinseed, YEP = yellow perch, NOP = northern pike, CT = cutthroat trout, SCR = black crappie, PWF = pygmy whitefish, BBH = brown bullhead, TEN = tench, TIM = tiger musky, COH = coho salmon, SMB = smallmouth bass, SCF = northern squawfish, SU = sucker spp., MWF = mountain whitefish, BLG = bluegill, RSS = redside shiner, CAR = carp, CHS = chiselmouth chub, CCF = channel catfish, WRB = wild rainbow trout, UTC = Utah chub, BRT = brown trout, LCT = lahontan cutthroat, HYB = cutthroat x rainbow hybrids, GSF = green sunfish, MTS = mountain sucker, BKT = brook trout.

Appendix F. Zooplankton composition and size structure for ten Idaho waters with fingerling-catchable stocking evaluations, 1993.

Location	Date	Taxonomic group	Relative abundance by size (mmZ								
			0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25
Spirit Lake	08/10	Bosmina	3	4							
		Copepods	201	978	163	28	4				
		Daphnia	9	60	75	77	14				
Hauser Lake	08/15	Bosmina									
		Copepods	3	2	1						
		Daphnia		1	3	10					
Magic Reservoir	07/02	Bosmina									
		Copepods	47	212	33	4					
		Daphnia		7	23	36	28	23	15	7	3
Little Wood Reservoir	07/02	Bosmina									
		Copepods	1	4	6	2	2				
		Daphnia		3	4	5	7	6			
	07/28	Bosmina									
		Copepods	3	19	36	22	4	1	2		
		Daphnia		68	36	31	98	78	22	5	2
Daniels Reservoir	07/14	Bosmina									
		Copepods	242	321	149	120					
		Daphnia	2	57	138	148	85	73	7	3	1
	07/21	Bosmina		7	1						
		Copepods	23	64	42	3					
		Daphnia	2	23	18	27	8	9	3	2	
Twin Lakes	07/16	Bosmina		10							
		Copepods	55	247	133	71	11				
		Daphnia	2	26	66	29	13	7	10	5	
Winder Reservoir	07/15	Bosmina		2							
		Copepods	62	118	188	8					
		Daphnia	28	166	289	168	141	43	22	6	
Treasureton Reservoir	07/14	Bosmina									
		Copepods	44	150	27	19	15				
		Daphnia	4	10	36	56	24	14	5	5	1
Chesterfield Reservoir	07/16	Bosmina									
		Copepods	37	156	107	43	8				
		Daphnia	39	141	68	20	29	14	10	9	7
24-Mile Reservoir	06/30	Bosmina									
		Copepods	16	51	19	25	10				
		Daphnia		2	21	14	11	5	10	1	
	07/16	Bosmina									
		Copepods	2	6	3	4	3				
		Daphnia			1		2				
	09/22	Bosmina									
		Copepods	2	2	1						
		Daphnia	1		17	5		1	2		

J1 AF

Appendix G. Temperature and oxygen profiles for ten Idaho waters with fingerling-catchable stocking evaluations, 1993.

Date	Depth (m)	Dissolved oxygen (mg/l)	Temperature (°C)	Date	Depth (m)	Dissolved oxygen (mg/l)	Temperature (°C)
			Spirit Lake				
06/26	surface	10.4	18.0	08/10	surface	10.2	18
	1	10.8	15.0		1	10.0	18
	2	10.8	15.0		2	10.2	18
	3	11.0	14.5		3	10.2	18
	4	11.0	13.5		4	10.2	17
	5	11.1	13.5		5	12.4	16
	6	12.0	10.0		6	12.4	14
	7	12.0	7.5		7	12.6	11
	8	11.1	6.0		8	10.4	7
	9	9.1	4.5		9	7.4	6
	10	8.6	4.0		10	6.2	5
	11	8.3	4.0		11	5.8	5
	12	8.4	3.5		12	5.8	4
	13	8.7	3.5		13	5.8	4
	15	8.8	3.0		15	5.6	3
	20	8.5	2.0		20	4.4	2
	25	4.9	2.0		25	2.0	2
	27	4.5	2.0				
			Hauser Lake				
06/25	surface	10.2	16	08/10	surface	10.2	20
	1	10.0	16		1	10.0	20
	2	10.0	16		2	9.8	20
	3	11.1	14		3	10.0	19
	4	10.0	14		4	10.2	15
	5	9.4	12		5	7.0	13
	6	5.8	7		6	5.5	11
	7	3.9	5		7	2.2	7
	8	3.0	5		8	2.8	6
	9	1.9	4		9	2.6	6
	10	1.9	4		10	2.5	5
	11	2.9	4		11	3.2	5
	12	2.1	4				

Appendix G. continued.

Date	Depth (m)	Dissolved oxygen (mg/l)	Temperature (°C)	Date	Depth (m)	Dissolved oxygen (mg/l)	Temperature (°C)
			Magic Reservoir				
07/02	surface	11.0	14	07/28	surface	10.0	15
	1	10.8	14		1	9.8	15
	2	10.7	13		2	10.0	14
	3	10.6	13		3	9.8	14
	4	10.4	13		4	9.6	14
	5	10.5	13		5	9.5	13
	6	10.4	13		6	9.5	13
	7	10.4	13		7	9.5	13
	8	10.2	13		8	9.4	13
	9	10.2	12		9	9.4	13
	10	10.0	12		10	9.3	13
	11	9.6	11		11	9.0	13
	12	9.4	10		12	8.8	13
					13	8.5	12
					15	8.4	12
					20	6.6	11
					25	5.0	11
					30	2.8	9
			Little Wood Reservoir				
07/02	surface	11.5	13.5	07/28	surface	12.5	14.0
	1	11.3	13.5		1	12.4	13.0
	2	11.2	13.5		2	12.5	13.0
	3	11.2	13.0		3	12.1	13.0
	4	11.0	13.0		4	12.2	13.0
	5	10.7	13.0		5	12.0	13.0
	7	10.6	13.0		7	11.8	13.0
	10	10.2	10.0		10	9.7	11.0
	15	10.3	8.0		15	0.0	10.0
	20	10.4	7.5		20	8.8	9.7
	25	10.2	7.5		25	8.2	9.0
	30	10.8	7.0		30	8.4	9.0
			Springfield Lake				
06/15	surface	13.2	15.0	07/13	surface	12.8	15.5
	1	13.8	15.0		1	12.8	15.0
	2	14.0	13.0		2	12.2	13.2
					3	10.2	13.0
09/23	surface	13.8	9.0				
	1	14.0	9.0				
	2	14.0	9.0				
	3	12.2	9.0				
	4	10.0	9.0				

Appendix G. continued.

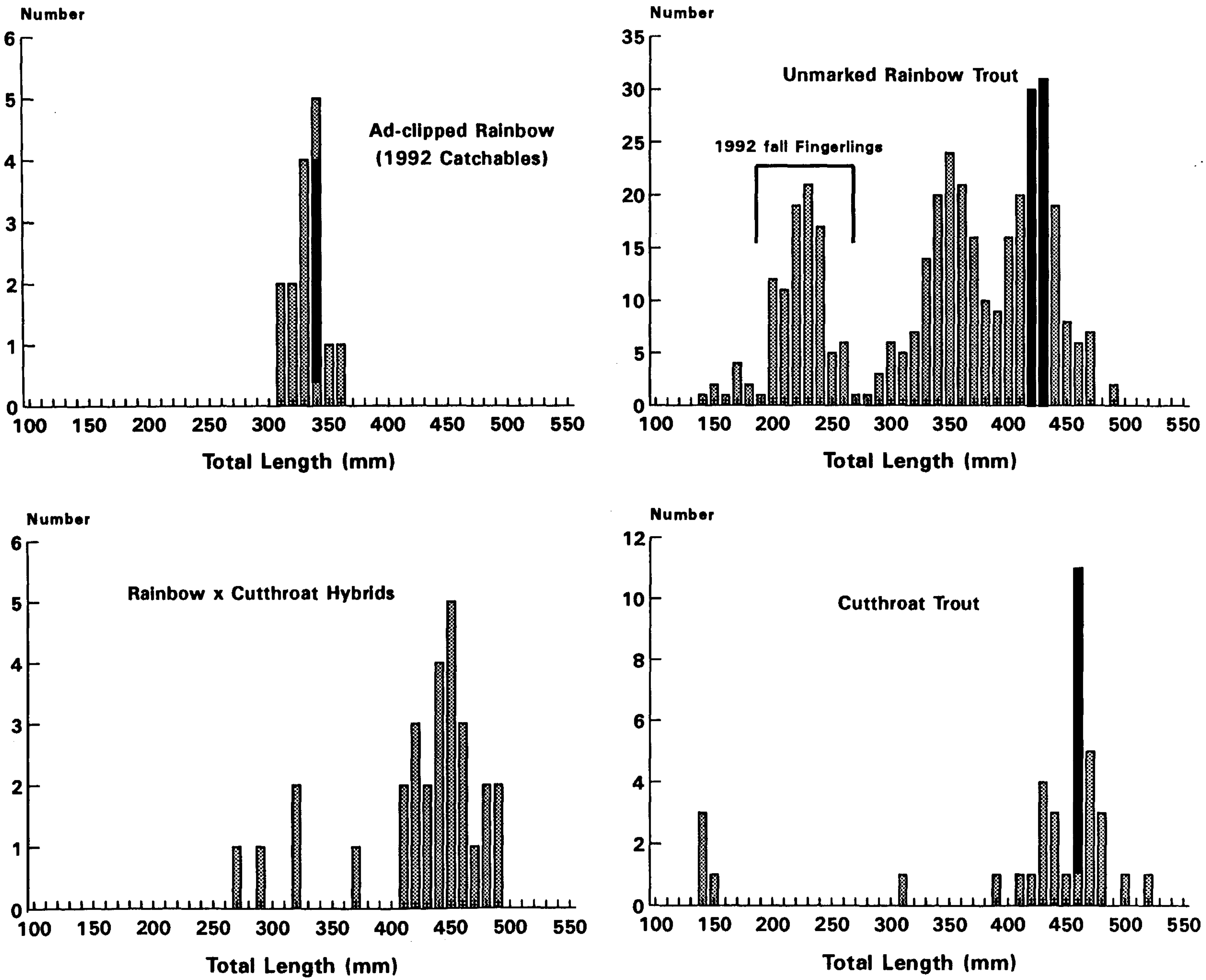
Date	Depth (ml	Dissolved oxygen (ma/11	Temperature (°Cl	Date	Depth (m)	Dissolved oxygen (ma/1)	Temperature (°C)
			Daniels Reservoir				
06/17	surface	13.3	14.0	07/14	surface	12.4	17.0
	1	11.2	14.0		1	12.2	17.0
	2	11.2	14.0		2	12.6	15.5
	3	11.2	14.0		3	12.0	15.0
	4	11.2	14.0		4	11.8	15.8
	5	11.0	14.0		5	10.6	15.0
	6	11.0	13.5		6	9.2	14.5
	7	10.2	11.5		7	6.7	12.5
	8	8.8	11.0		8	4.2	12.5
	9	6.2	10.5		9	2.8	10.0
	10	4.2	11.0		10	3.2	8.0
	11	3.5	8.5		11	3.3	7.0
	12	3.0	8.0		12	3.6	7.0
09/21	surface	8.8	11.0				
	1	9.0	11.0				
	2	8.8	11.0				
	3	9.0	11.0				
	4	9.0	10.5				
	5	8.8	10.5				
	6	8.8	10.5				
	7	9.0	10.5				
	8	8.6	10.0				
	9	6.2	10.0				
	10	2.8	9.0				
			Twin Lakes				
06/16	surface	10.4	13.5	07/14	surface	9.5	17.0
	1	10.0	13.5		1	9.0	17.0
	2	10.2	13.5		2	9.9	16.5
	3	10.2	13.5		3	9.9	16.5
	4	10.2	13.0		4	9.9	16.5
	5	9.8	13.0		5	9.7	16.0
	6	9.6	13.0		6	9.4	16.0
	7	8.0	10.0		7	9.1	15.0
	8	4.5	10.0		8	3.6	13.0
	9	3.8	9.0		9	3.4	12.5
	10	3.0	8.5		10	3.5	12.0
	11	1.3	8.0				
	12	2.8	7.5				
	13	2.0	7.0				

Appendix G. continued.

Date	Depth (m)	Dissolved oxygen (ma/1)	Temperature (°C)	Date	Depth (m)	Dissolved oxygen (ma/1)	Temperature (°C)
Twin Lakes (continued)							
09/21	surface	10.4	12.5				
	1	10.0	12.5				
	2	9.4	12.5				
	3	9.0	12.0				
	4	9.0	12.0				
	5	9.0	12.0				
	6	8.4	12.0				
	7	8.5	12.0				
Winder Reservoir							
07/15	surface	9.6	17.8				
	1	10.0	17.0				
	2	9.8	16.5				
	3	9.6	16.5				
	4	9.4	16.0				
	5	8.4	14.5				
	6	7.8	12.0				
	7	8.2	13.0				
	8	8.2	12.0				
Chesterfield Reservoir							
07/16	surface	11.6	17.0				
	1	10.6	16.5				
	2	9.4	16.0				
	3	9.2	15.2				
	4	9.0	15.0				
	5	8.9	15.0				
	6	9.2	15.0				
	7	8.0	14.5				
	8	7.6	14.2				
	9	6.8	14.0				
	10	3.2	12.0				
24-Mile Reservoir							
06/30	surface	11.4	16.0	07/16	surface	13.5	17.0
	1	11.2	16.0		1	13.4	17.0
	2	11.2	16.0		2	13.4	16.5
	3	13.2	15.0		3	13.8	15.7
	4	11.8	15.0		4	15.2	15.5
	5	11.8	14.5				
	6	13.6	13.5				
09/22	surface	13.2	11.0				
	1	13.2	11.0				
	2	12.5	11.0				
	3	13.0	10.0				
	4	9.4	9.5				
	5	9.2	9.0				

Appendix H. Mark-recapture data for population estimates on Daniels Reservoir, May 1993. The spring 1993 fish were stocked after marking runs for the other five groups.

Fish Group	Total marked	Total recaptures	Marked recaptures	Recapture Rate
Spring 1992 catchables	15	13	2	13.3
Fall 1992 fingerlings	103	68	2	1.9
Unmarked rainbow trout	275	106	18	6.5
Cutthroat x rainbow hybrids	28	14	1	3.6
Cutthroat	38	8	0	0
Spring 1993 catchable-size	4,690	-	218	4.6



Appendix I. Length-frequencies of trout in Daniels Reservoir, May 1993.

JOB PERFORMANCE REPORT

State of: **Idaho**

Name: **Put-and-Take Hatchery Trout Evaluations**

Project: **F-73-R-16**

Title: **Rainbow Trout Food Habits and Growth Potential**

Subproject: V

Study: III

Job: 2

Period Covered: April 1. 1993 to March 31. 1994

ABSTRACT

We monitored hatchery rainbow trout *Oncorhynchus mykiss* growth and diet composition in five Idaho reservoirs from May through October 1993. Food habits varied among lakes and by month within lakes. Trout growth was best in waters where macroinvertebrates dominated the diet. In lakes with diverse forage bases, rainbow trout switched to larger forage items as they grew. In Magic Reservoir, all size classes of fish used the same primary prey type in most months. Rainbow trout growth rates were greatest in Springfield Reservoir where mean total weight of stomach contents was the highest, sampling catch rates were the lowest, and there was a population of large macroinvertebrates (amphipods) available for rainbow trout consumption. Rainbow trout growth was slowest in Twin Lakes where the mean total weight of stomach contents were the lowest, competitors were present, and the diet was dominated by zooplankton. Information on food habits may be useful to predict the growth potential of rainbow trout in lakes and reservoirs.

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INTRODUCTION

Most of Idaho's lake and reservoir rainbow trout Oncorhynchus mykiss fisheries are supported by stocking hatchery trout. Some of these waters consistently produce trophy size (>508 mm) rainbow trout while others rarely grow large trout. There are currently no guidelines that describe the potential of Idaho waters to produce quality rainbow trout.

Understanding what influences the growth and survival of stocked rainbow trout in lakes and reservoirs will help us predict the fishery potential of individual waters. Factors that affect the growth and survival of rainbow trout include: lake productivity, genetic strain of trout and age at maturity, stocking rates (density), thermal regime, and diet. Eric Parkinson (British Columbia Fisheries Branch, personal communication) noted that longevity, forage base, and harvest are the most important factors affecting trophy rainbow trout potential in British Columbia lakes and reservoirs. Forage communities and longevity are unlikely to change; therefore, most of our management for trophy rainbow trout focuses on restricting harvest. In Idaho, a 508 mm minimum length and two fish limit is the standard regulation on trophy trout lakes and reservoirs. Still, if forage communities play a major role in production of trophy rainbow trout, perhaps we can use indices of forage availability or forage communities to predict which of our waters are best suited for trophy management.

The importance of forage community to the growth of rainbow trout in Idaho is not well understood. Rainbow trout will feed on almost all food types available to them (Naito 1990). Piscivory in predators is not obligate, and consumption of fish prey is influenced by prey body size, abundance, behavior and habitat preference (Keast 1985). Some strains of rainbow trout are more piscivorous than others. It is clear, however, that trout do not require forage fish to reach trophy size if large macroinvertebrate forage is abundant (Naito 1990). Food requirements will change as body size increases to maximize net energy gain relative to expenditure. Relative importance of smaller prey items in the diet will decrease as trout grow, and use of larger prey items such as fish, terrestrial insects, and aquatic insects will increase (Irvine and Northcote 1982). Predatory fish prefer to devour the largest possible prey. Hartman (1958) showed that, for rainbow trout, the maximum size of prey consumed is directly related to size of mouth gap.

In a preliminary diet study conducted in Salmon Falls Creek Reservoir (Jarcik and Dillon 1991), rainbow trout diets changed dramatically with season and size of fish. As fish grew beyond 225 mm, diet shifted from primarily zooplankton to larger forage items such as aquatic insect larvae, terrestrial insects and fish. Prey fish, primarily young-of-the-year yellow perch Perca flavescens were only a significant part of the diet for fish over 450 mm and only in September and October when other forage became less available. A shift to larger prey may be necessary when rainbow trout reach some threshold size, although threshold size may very among strains (Hensler 1987).

It is unclear how availability of individual prey types (i.e. fish, zooplankton, terrestrial insects, aquatic insects) influence overall trout growth. This study was undertaken to determine if forage community can be used as an indicator of trophy potential for our hatchery rainbow trout waters. By identifying what prey types are used by large rainbow trout we may be able to determine if some Idaho lakes and reservoirs are better suited for trophy trout management.

PROJECT GOAL

To maximize the effectiveness of trout stocking programs in Idaho lakes and reservoirs to meet management goals for Idaho's fisheries.

OBJECTIVE

1. To describe the relationships between food habits and growth and condition of hatchery rainbow trout in five Idaho reservoirs.

STUDY AREA

We selected six waters for this study including three managed with trophy trout regulations and three with general harvest regulations. These waters represented a range of productivities and species composition (Job 1 this report). We sampled trout from Daniels Reservoir, Twin Lakes, 24-Mile Reservoir, and Springfield Reservoir in Region 5, Magic Reservoir in Region 4, and Little Payette Lake in Region 3. Sampling from Little Payette Lake was abandoned due . to poor sampling success.

METHODS

Sampling

We sampled rainbow trout food habits monthly from May through October in each study water. We collected fish by electrofishing at night in the littoral zones. We sampled fish with a Smith Root electrofishing boat. Fish were stunned with pulsed direct current powered by a 5,000-watt generator. Each month our sampling goal was to collect 10 trout for every 100 mm length group present in each study water.

We measured total lengths (mm) and weights (g) of all rainbow trout captured to the nearest 5 mm and 5 g, respectively. We removed stomach contents by gastric flushing (He and Wurtsbaugh 1993). We used a 60 cc syringe connected to rubber surgical tubing. The stomach contents were evacuated into a wire mesh strainer, placed in plastic bags, and preserved in 10% formalin. In Magic Reservoir, we removed stomachs from all sampled fish (after flushing) to determine efficiency of the gastric lavage. Whole digestive tracts were removed by cutting the esophagus as far forward as possible and cutting below the ceacae. In the remaining waters, we removed stomachs from three fish in each 100 mm length group after flushing. All samples were preserved in 10% formalin.

In the laboratory, we identified and sorted individual stomach contents into 10 general prey types: aquatic insect larvae, aquatic insect adults, terrestrial insects, fish, zooplankton, amphipods, vegetation, corixids, snails, and unidentified. After sorting the contents, we dried the individual food types overnight at 105°C and weighed them with an analytical balance (Bowen 1985).

To determine flushing efficiency, digestive tracts were cut open and the unflushed contents were dried overnight at 105°C. We determined total stomach weight by adding the weight of flushed contents to weight of contents remaining in the stomach. We expressed flushing efficiency as a percentage of the total stomach contents successfully evacuated.

To assess condition of sampled fish, we eviscerated 30-100% of the fish used for food habits analysis to determine pyloric fat index (PFI; Goede 1987). We also calculated relative weights (Anderson 1980).

Data Analysis

To describe overall diet differences by fish size, we grouped fish into 100 mm length groups (100-199 mm, 200-299 mm, 300-399 mm, etc.). We calculated the percent of individual food items in the diet from the combined amount (dry weight) for all fish in each length group for the entire sampling period (May-October).

To describe seasonal changes in diet within lakes, we summarized the diet data by fish length group and month using the dry weight for each food type.

We compared food habits (mean total weight of stomach contents and proportions of different prey types) to rainbow trout growth in each water. We summarized the mean total weight of stomach contents for each size class over the entire sampling period.

As part of fingerling-catchable evaluations (Job 1, this report) we have used both relative weight (Wr) and PFI as indices to assess trout condition. For fish sampled from Magic Reservoir, we plotted individual Wr values against individual PFI values to see how well the two condition indices were correlated.

RESULTS

We completed six sampling trips to five reservoirs once a month from May through October. Lengths, weights, and stomach samples were collected from 616 trout. For some lakes and months, electrofishing catch rates and sample sizes were low (Appendix A).

A combined average of 91% of the food items were flushed from rainbow trout in Daniels Reservoir, Twin Lakes, 24-Mile Reservoir, and Magic Reservoir over the sampling period (Appendix B). Magic Reservoir had the lowest average of 74% from May to October. In Magic Reservoir, rainbow trout diets were composed mainly of snails in September and October. This reduced the pumping efficiency substantially. Of the food items we observed, snails were the only item that were not easily flushed from the stomachs. Pumping efficiency was not determined in Springfield Reservoir due to low sample sizes.

Diet fluctuated by length group in all study waters except for Magic Reservoir (Figures 1-5). In Magic Reservoir, aquatic insect larvae, mainly chironomids, dominate the diet in all size classes of fish throughout most of the sampling **period.**

Magic Reservoir

In Magic Reservoir in May, diet of 100-199 mm fish was 100% zooplankton (Figure 6). In June, there was a shift to aquatic insect larvae which represented 75% of the diet with only 12% zooplankton. No fish in the 100-199 mm length group were captured from July through October.

For rainbow trout from 200-299 mm, zooplankton was 96% of the diet in May and then decreased to only 9% in June (Figure 6). Zooplankton was not a substantial part of the diet again until October. Aquatic insect larvae dominated the diet in June, represented 100% of the diet in July and August, and then decreased in importance in September and October. Snails were only present in the diet in September and October where they comprised 5% and 34% of the diet, respectively.

Based on one captured fish in May, zooplankton was 100% of the diet for fish in the 300 mm length group (Figure 6). Aquatic larvae and vegetation dominated the diet in June for fish in the 300 mm size class. In July and August, aquatic insect larvae comprised 100% of the diet. Aquatic insect larvae decreased to half of the diet in September and were not present in October. Snails provided the bulk of the diet in September and October as chironomids declined in importance. Snails were rarely found in the diet in other months.

Only one fish >400 mm was captured during the May sampling effort (Figure 6). Aquatic insect larvae dominated the diet from June through August, decreased in September, and were not utilized in October. Snails provided the bulk of the diet in September and October.

Daniels Reservoir

For fish in the 200 mm size class, only one fish was captured in the August sampling and none were captured in September or October. Aquatic insect larvae were an important part of the diet from May through July, and dominated the diet

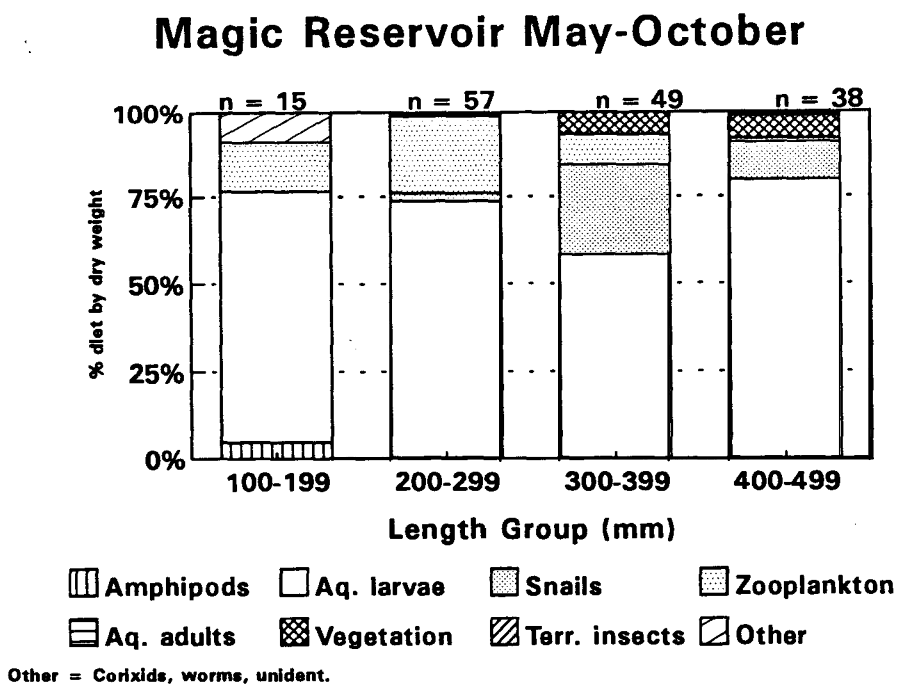

Figure 1. May through October food habits of hatchery rainbow trout in Magic Reservoir.

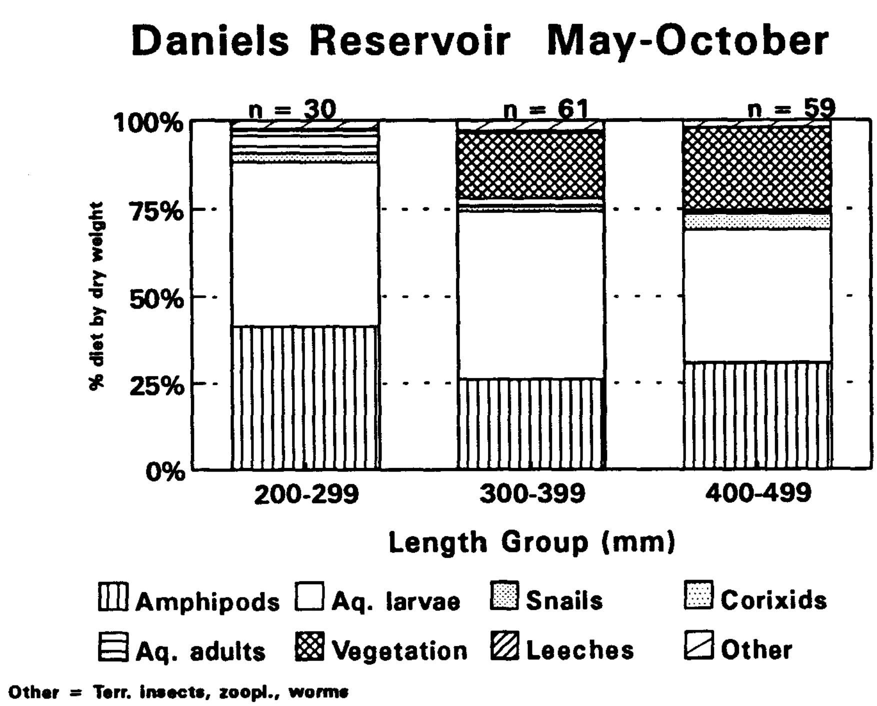

Figure 2. May through October food habits of hatchery rainbow trout in Daniels Reservoir.

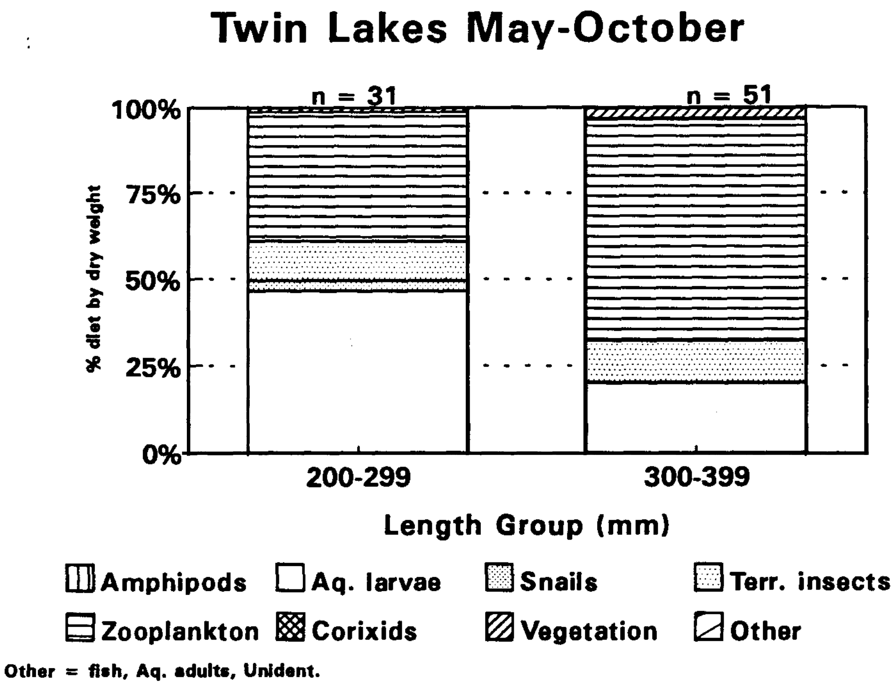

Figure 3. May through October food habits of hatchery rainbow trout in Twin Lakes.

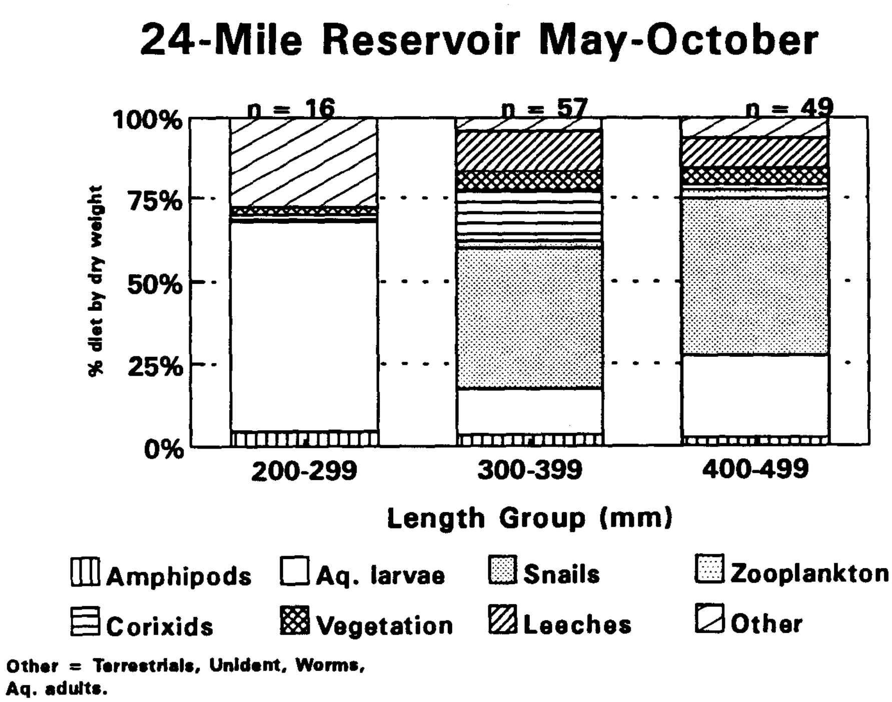

Figure 4. May through October food habits of hatchery rainbow trout in 24-Mile Reservoir.

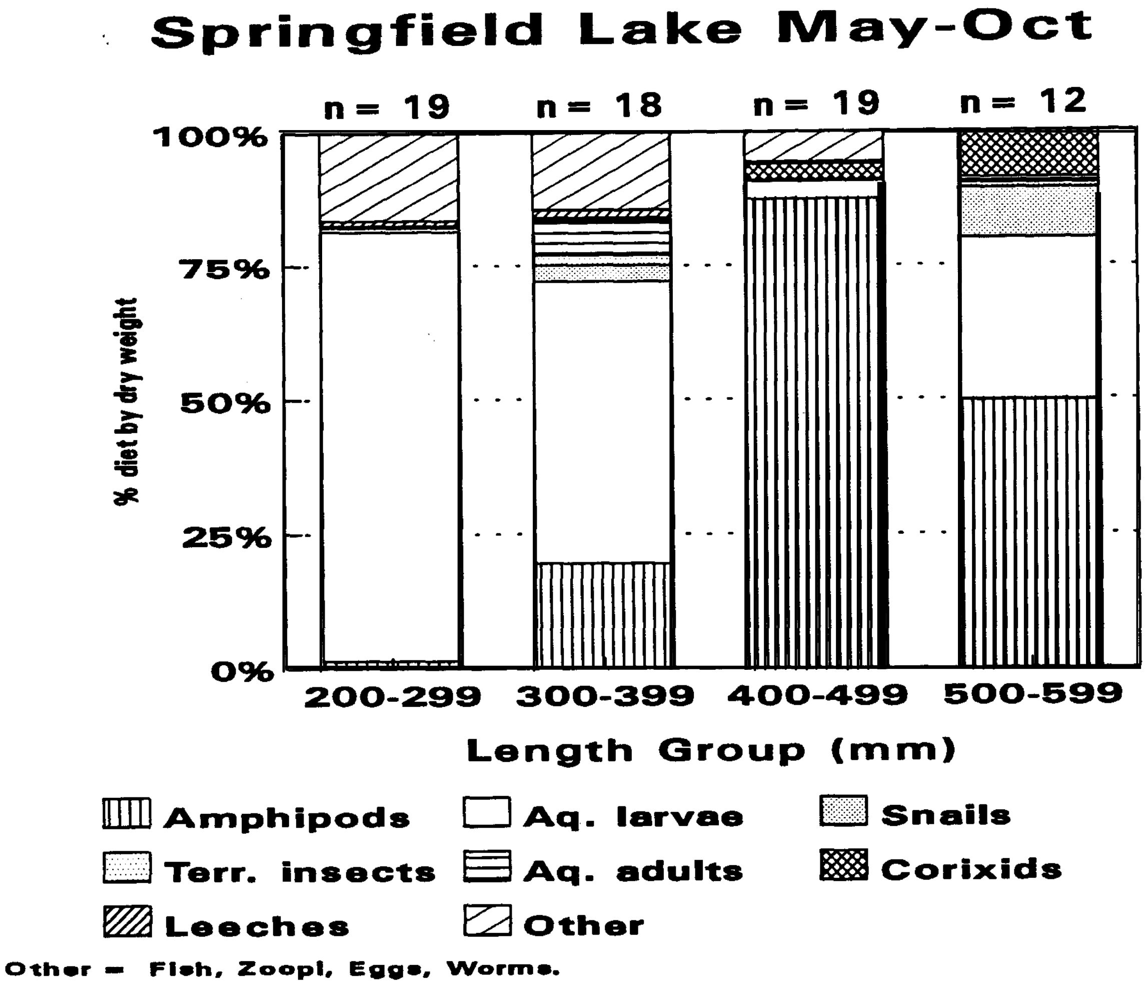

Figure 5. May through October food habits of hatchery rainbow trout in Springfield Lake.

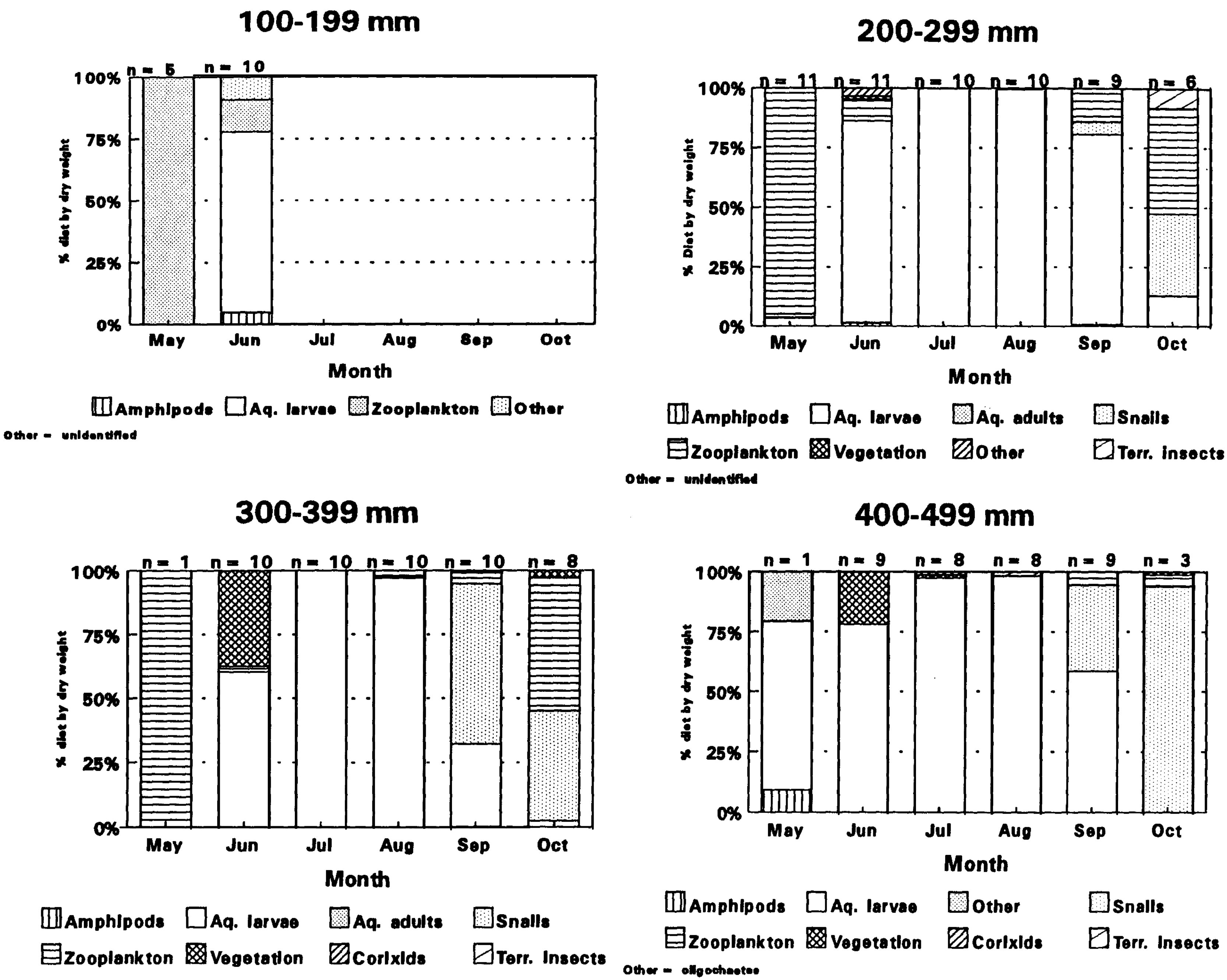

Figure 6. May through October food habits for four size classes of rainbow trout in Magic Reservoir

in June (Figure 7). The proportion of amphipods in the diet fluctuated throughout the season but was highest in July, comprising 60% of the diet.

Of fish in the 300 mm size class, aquatic insect larvae were a major part of the diet from May through September, but were not present in October (Figure 7). Amphipods increased steadily in the diet from May to August, peaking at 50% and then declining in September and October. Vegetation was greater than 50% of the diet in October and was also present in June and September. Zooplankton were present in small quantities in August and September.

For the largest fish (400-499 mm), amphipods comprised more than 50% of the diet in May and August but were also present in lesser amounts in other months (Figure 7). Aquatic insect larvae comprised more than 75% of the diet in June, July, and September, but were also present in May and August. In October, vegetation was greater than 50% of the diet.

Twin Lakes

Only one fish in the 200-299 mm size class was captured in September and October. Aquatic insect larvae dominated the diet in May and were substantial in June and July (Figure 8). Zooplankton comprised 25% of the diet or more from May through July. Terrestrial insects were a substantial part of the diet in June and July. Vegetation was present in stomachs in July.

Zooplankton dominated the diet of 300 mm fish throughout the season except in July when it only comprised 10% of the diet (Figure 8). Aquatic insect larvae were utilized most in May and July, but were also present in the diet in June, August, and September. Terrestrial insects comprised a large percentage of the diet in August, but were not significant any other month.

24-Mile Reservoir

Corixids and terrestrial insects were the majority of prey items in May for fish in the 200-299 mm group (Figure 9). In other months aquatic insect larvae were an important part of the diet.

In 300-399 mm fish, there was more of a diversity in forage throughout the season compared to other reservoirs (Figure 9). Snails were abundant in the diet in May, July, August, and October. Leeches were most abundant in May and June, but were also present in August, September, and October. Aquatic insect larvae were present in the diet every month, but were most abundant in August and September.

In fish >400 mm, aquatic insect larvae were always present in the diet, but were most abundant in May and June (Figure 9). Amphipods were a small part of

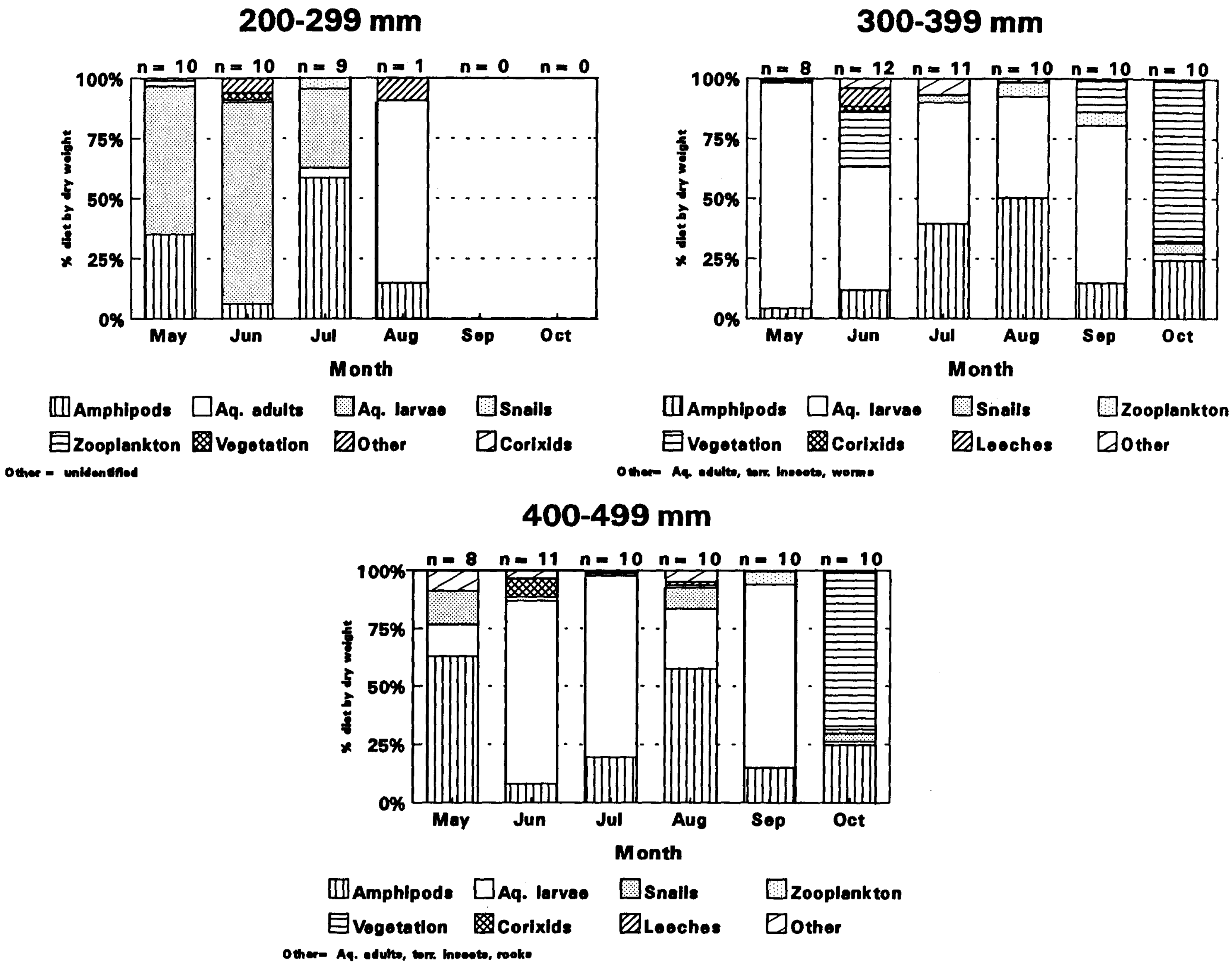

Figure 7. May through October food habits for three size classes of rainbow trout in Daniels Reservoir.

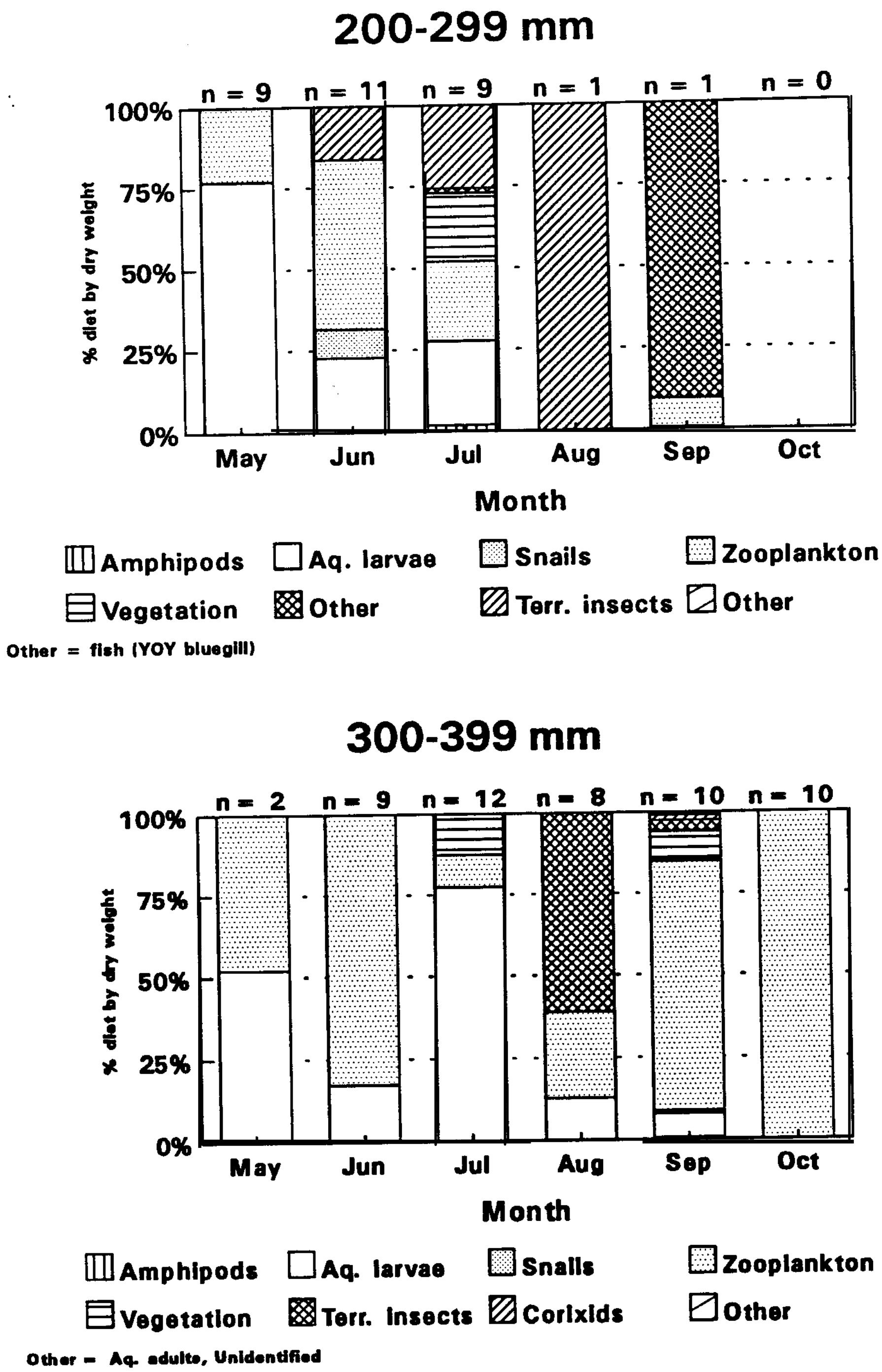

Figure 8. May through October food habits for two size classes of rainbow trout in Twin Lakes.

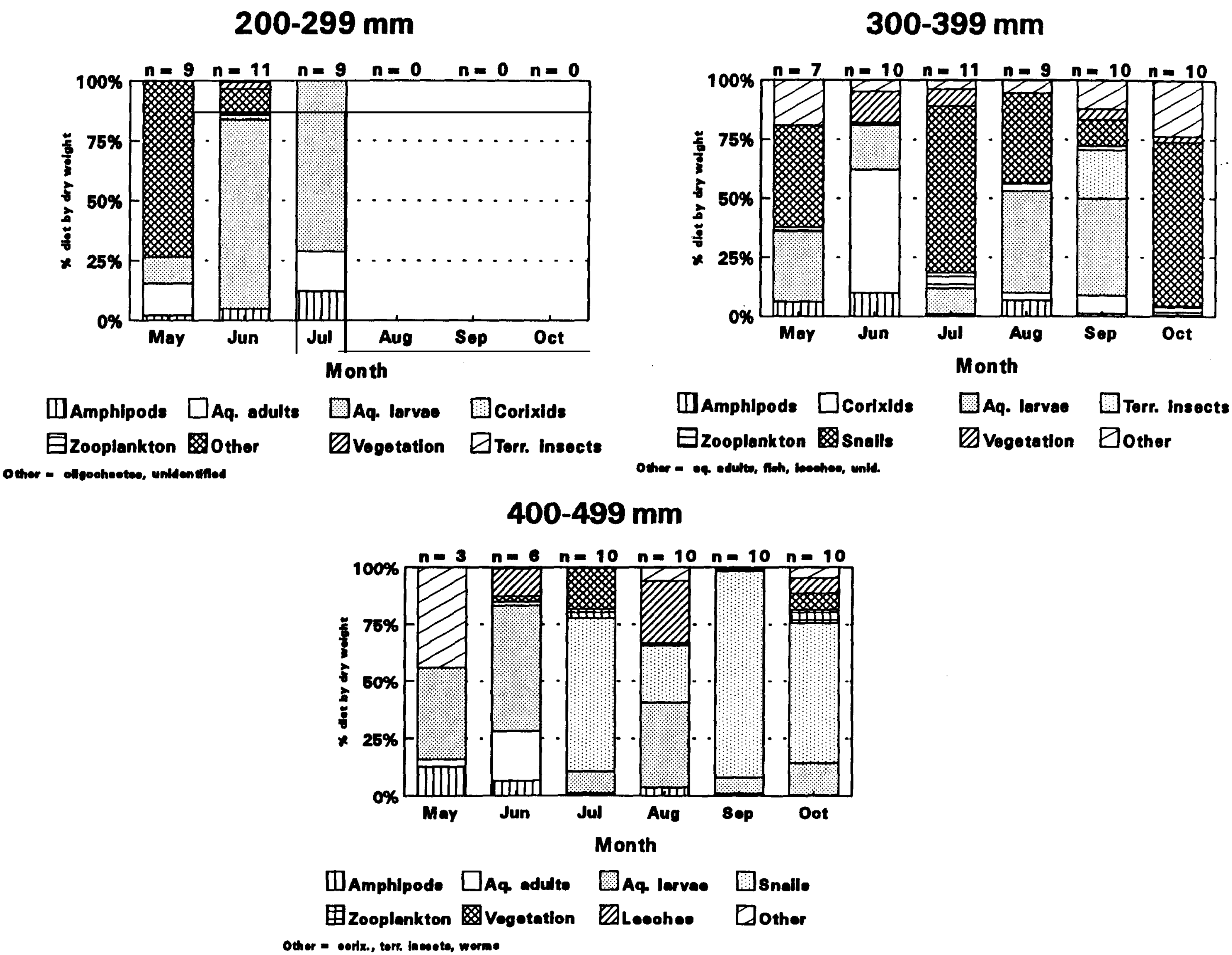

Figure 9. May through October food habits for three size classes of rainbow trout in 24-Mile Reservoir.

the diet in may and June where they contributed 13% and 5% of the diet, respectively. Amphipods were not a substantial part of the diet in any other month. Snails comprised more of the diet throughout the season than for smaller size groups of fish.

Springfield Lake,

Catch rates were low throughout the season. Consequently sample sizes were small for most size classes of fish. Fish 200-299 mm were only captured in May and June. Aquatic insect larvae were the dominant forage items in both months (Figure 10).

For fish in the 300-399 mm length group, aquatic insect larvae were the primary forage item in May and June (Figure 10). Amphipods dominated the diet later in the season in July and August. Aquatic insect adults peaked in July at 33% of the diet, but were not present in May or August. There were no samples of 300-399 mm fish in the September and October sampling trips.

Aquatic insect larvae and amphipods were the main forage items of the 400 mm and 500 mm fish (Figures 10). The diet was dominated by aquatic insect larvae in May and June and then by amphipods from July to October.

Growth Rates

Best overall growth rates were in reservoirs where there were large prey items, and the mean total weight of stomach contents was high. Mean lengths of sampled fish (within each 100 mm length group) were similar among lakes (Appendix C). Springfield Reservoir had the highest growth rates and it also had the highest mean total weight of stomach contents for all size classes of fish at 0.950 g (dry weight) per fish (Figure 11). Fish diets in Springfield reservoir were dominated by amphipods. Twin Lakes had the lowest growth rates and the lowest mean total weight of stomach contents with an average 0.182 g (dry weight) per fish. Zooplankton was the main food item found in the diet of Twin Lakes fish over 300 mm throughout the season. In contrast, zooplankton was not a substantial percentage of the diet at any time in lakes with high rainbow trout growth rates.

Condition Comparisons

Comparisons of pyloric fat and relative weight in Magic Reservoir demonstrated a poor relationship between the two indices (Appendix D).

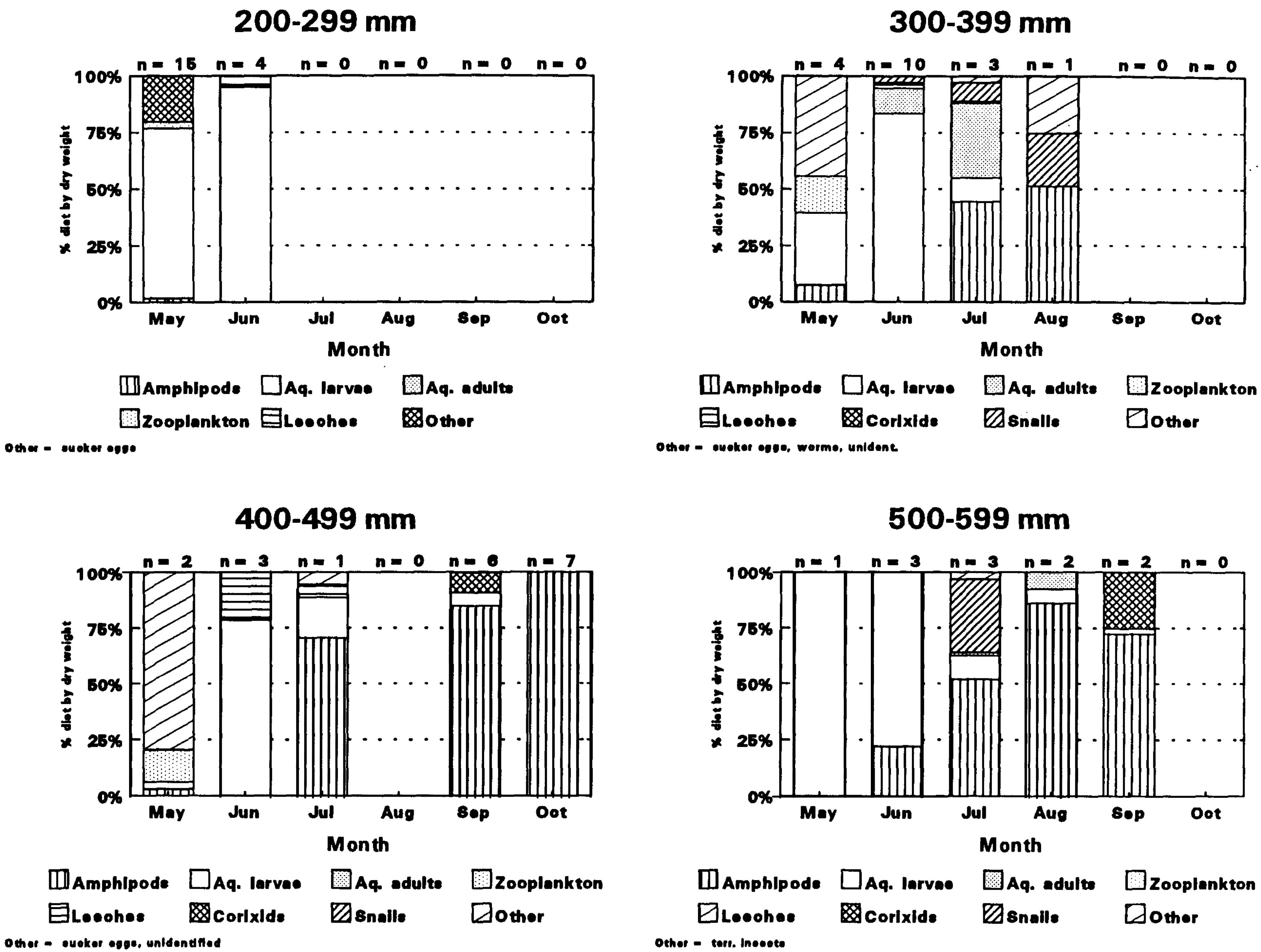

Figure 10. May through October food habits for four size classes of rainbow trout in Springfield Lake.

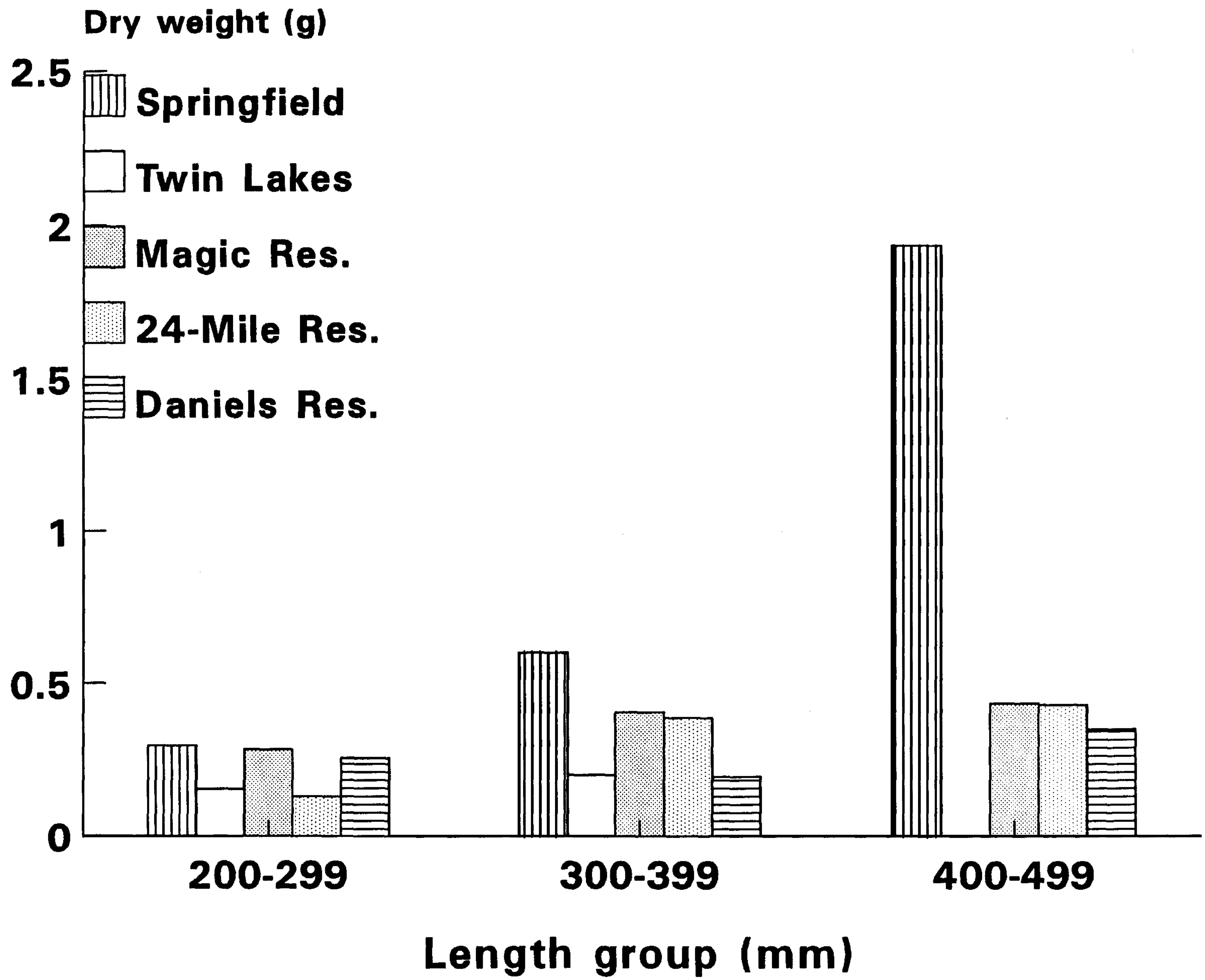

Figure 11. Mean total weight of hatchery rainbow trout stomach contents, by length group, in five southern Idaho reservoirs.

DISCUSSION

For rainbow trout to achieve larger sizes and maintain growth, they must maximize energy intake while reducing energy expenditure. Threshold for prey size, as described by Galbraith (1967), shows evidence that growth efficiency depends upon prey size, specifically because of greater net energy acquired with larger food particles. Zooplankton contain relatively high caloric content, but due to their small size it may not be efficient for larger rainbow trout to utilize them. Zooplankton >_l.5 mm are present in all of the study waters (Job 1, this report), suggesting zooplankton availability is not limited by competition. Hensler (1987) showed that efficiency in straining food items smaller than 2 mm decreased as trout grew beyond 350 mm. Our results confirm that larger macroinvertebrates such as aquatic insect larvae and amphipods, if abundant, are sufficient themselves to grow large trout. Diets consisting of fish are not necessary to produce large trout (Jarcik and Dillon 1991; Crossman and Larkin 1959). Prey fish can reduce trout growth by competing with the smaller trout for resources and slowing overall growth (Crossman 1959).

There were definite shifts in overall diet composition by size class in most of the reservoirs. In reservoirs with a diversity of food items (Daniels, 24-Mile, and Springfield reservoirs), fish began to use larger prey items as they increased in length. In Magic Reservoir, however, aquatic insect larvae (primarily chironomids) dominated the overall diet for all size classes. In Twin Lakes, zooplankton was a major component of the diet for all size classes of fish.

Diet also varied by month in each reservoir. Aquatic insect larvae dominated diets throughout most of the season. Shifts in the diet were most noticeable from May to June, probably coinciding with increased abundance of aquatic insect larvae. As insect larvae abundance declined in the fall, fish used other forage such as zooplankton and snails. Zooplankton forage was utilized most by fish under 300 mm except in the fall in a few reservoirs when larger prey such as insect larvae and amphipods may have become less available.

Our results suggest that trout densities may be one factor limiting growth in waters with populations of macroinvertebrates. In several of the waters, (Magic, 24-Mile, and Daniels reservoirs) rainbow trout food habits were similar, with aquatic larvae dominating the diet in most months. Although we did not monitor electrofishing catch per effort, our sampling results clearly demonstrated a range of trout densities in the study waters. In Daniels and 24-Mile reservoirs, electrofishing catch rates were high and rainbow trout relative weights were low (Job 1, this report). This suggests that high stocking rates and restrictive harvest regulations in these waters may be stockpiling fish and reducing growth. Donald and Anderson (1982) noted that crowding will increase mortality, and additional stocking will not necessarily increase production or numbers of trout. In Springfield Reservoir, electrofishing catch rates for rainbow trout were very low, growth was high, and the food habits data indicated there may be a higher abundance of macroinvertebrate prey.

Interspecific competition is another limitation to growth and survival of stocked trout. Growth of small rainbow trout in Paul Lake, British Columbia declined noticeably when redside shiners Richardsonius balteatus were introduced. As redside shiners increased in abundance, amphipods became rare in trout diets (Crossman.and Larkin 1959). Twin Lakes has several potential competitors for macroinvertebrate forage (bluegill Lepomis macrochirus, largemouth bass Micropterus salmoides, and carp Cvnrinus carnio). Twin Lakes had low electrofishing catch rates, growth rates were poor, and rainbow trout diets were composed mainly of zooplankton.

Trout growth appears to be most affected by abundance of large prey items and densities of fish. Reservoirs with populations of macroinvertabrates have potential of supporting trophy size fish, while waters with primarily small forage such as zooplankton may have little potential to support a trophy fishery.

Pyloric fat index indicated little variability in rainbow trout condition across the study waters or by month. In contrast, relative weight values varied substantially among individual fish and waters throughout the season. The PFI appears to be of little value except for describing fish in very poor or very good condition. Relative weight is less subjective and demonstrates fish condition more clearly.

Limitations of the Data

Difficulty in collecting adequate numbers of fish for each size class on every sampling trip accounts for some low sample sizes in the data. Results may differ if more fish of certain size classes could have been caught on some of the sampling trips.

Because we collected fish by electrofishing, we sampled only fish from the littoral zones of the study waters. If subpopulations of pelagic fish are present, their food habits could differ from the fish we sampled. Our intent, however, was to describe how rainbow trout food habits differ from lake to lake on a gross scale, and whether food habits were correlated with growth. Among at least the sections of the populations we sampled, food habits and growth were highly variable across waters.

Sampling by electrofishing can also stress fish severely and may cause regurgitation (Bowen 1983). Regurgitation may have occurred, adding bias to our results.

Large food items, particularly snails, were difficult to flush completely from the stomach. We did not attempt to correct our data based on flushing efficiencies. Other than in Magic Reservoir, however, flushing efficiencies approached 100% in most months (Appendix B).

RECOMMENDATIONS

1) Use forage community and diet composition data to help predict growth potential for hatchery rainbow trout in individual waters.

Invertebrate Forage Community	Trout Diet	Growth Potential
Small zooplankton (<1.5 mm)	Zooplankton	Low
Large zooplankton (>1.5 mm)	Zooplankton	Low
Zooplankton + Aq. insect larvae (abundant)	Insect larvae	Moderate
Zooplankton + Insect larvae (abundant) Amphipods (rare)	Insect larvae Amphipods	Moderate
Zooplankton + Insect larvae (abundant) Amphipods (abundant)	Amphipods Insect larvae	High
Zooplankton + Amphipods (abundant) Insect larvae (abundant) Leeches	Amphipods Leeches Insect larvae	High

2) Gastric lavage is effective on small prey items, but not on larger items such as snails. It is important to do some whole stomach analysis to validate for each water.

3) Use relative weight rather than pyloric fat to assess condition of rainbow trout in the field.

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A P P E N D I C E S

Appendix A. Total rainbow trout sampled from each study water by month and length group.

Length mm	May	June	July	August	September	October
Magic Reservoir						
100-199	5	10	-	-	-	-
200-299	11	11	10	10	9	6
300-399	1	10	10	10	10	8
400-499	1	9	8	8	9	3
Daniels Reservoir						
200-299	10	10	9	1	-	-
300-399	8	12	11	10	10	10
400-499	8	11	10	10	10	10
24-Mile Reservoir						
200-299	4	10	2	-	-	-
300-399	7	10	11	9	10	10
400-499	3	6	10	10	10	10
Twin Lakes						
200-299	9	11	9	1	1	
300-399	2	9	12	8	10	10
Springfield Reservoir						
200-299	15	4	-	-	-	
300-399	4	10	3	1	-	
400-499	2	3	1	-	6	7
500-599	1	3	3	2	2	

J2 AA

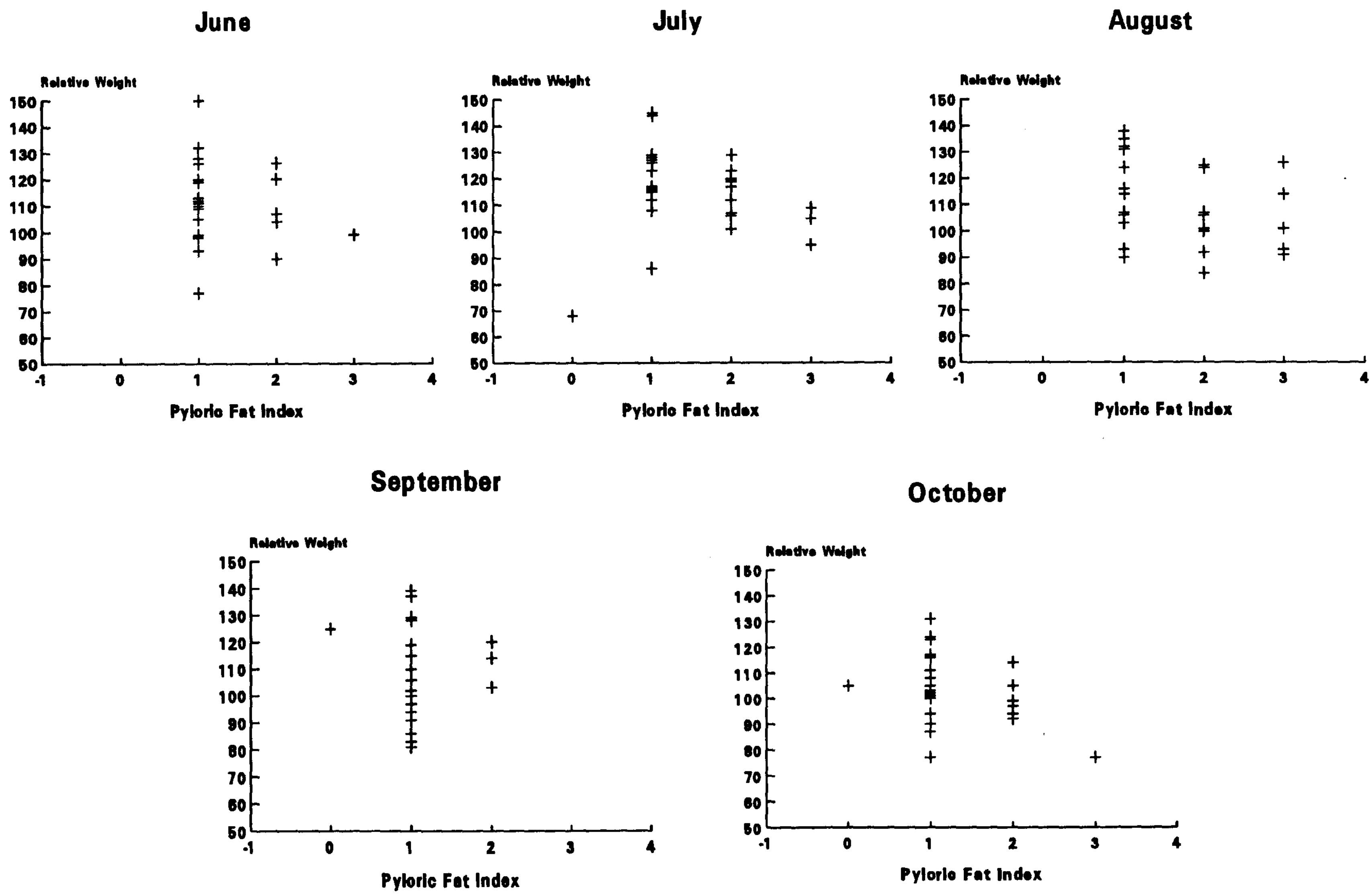
Appendix B. Efficiency of gastric lavage in percent for removal of food items from hatchery rainbow trout stomachs in five Idaho reservoirs June-October 1993.

Location	Month	Number stomachs lavaged	Number completely lavaged	Weight of contents lavaged (a)	Weight of contents not lavaged (a)	Combined weight of contents (a)	Contents lavaged (%)
Magic Reservoir	June	28	9	12.9	2.5	15.4	84
	August	26	23	0.2	14.9	15.1	99
	September	30	26	11.3	12.8	24.1	47
	October	29	26	4.2	2.2	6.5	66
Daniels Reservoir	June	10	9	5.1	0.4	5.5	93
	July	9	9	3.3	0	3.3	100
	August	7	5	4.4	0.5	4.9	90
	September	6	6	1.9	0	1.9	100
	October	7	2	8.9	0.5	9.3	95
24-Mile Reservoir	June	9	8	11.4	0	11.4	100
	July	8	8	5.9	0	5.9	100
	August	6	4	4.9	0.6	5.5	89
	September	5	4	5.5	0.3	5.9	94
	October	6	2	15.3	1.1	16.5	93
Twin Lakes	June	7	7	1.2	0	1.2	100
	July	6	4	1.8	0.1	1.9	94
	August	3	3	2.2	0	2.2	100
	September	4	4	4.8	0	4.8	100
	October	3	3	3.3	0	3.3	100

Appendix C. Mean length and range of lengths for rainbow trout sampled for food habits analysis in five southern Idaho reservoirs, 1993.

Location	Mean total length (mm) and range () within length group		
	200-299	300-399	400-499
Magic Reservoir	254.6 (200-290)	345.2 (300-390)	434.1 (400-490)
Daniels Reservoir	260.5 (200-290)	356.6 (300-390)	420.8 (400-490)
Twin Lakes	260.6 (220-290)	327.7 (300-380)	-
24-Mile Reservoir	252.5 (200-290)	367.9 (300-390)	437.9 (400-490)
Springfield Lake	254.5 (230-280)	341.1 (300-390)	445.0 (400-490)

J2 AC



Appendix D. Plots of relative weight versus pyloric fat index for individual hatchery rainbow trout in Magic Reservoir, June through October 1993.

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SIGNPAGE